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ON May 1 the offices of THE RAILROAD AND ENGINEERING JOURNAL will be removed to the new building, Nos. 45-49 Cedar Street. The correct address of the JOURNAL will therefore be, after May 1, No. 47 Cedar Street, New York City.

THE best method of protecting iron and steel structures from rust is an important question for engineers, and one on which there are wide differences of opinion. In another column a contributor expresses very decided opinions in favor of the use of red lead for this purpose, and gives some very good reasons in favor of his views. Discussion of this question may do much good; and statements of experience in this direction will be very useful. The use of iron and steel in bridges and other structures is now so general that the best protection of the metal against deterioration is a matter which should interest almost every one.

THE production of Bessemer steel in the United States last year, like the production of pig iron, was the largest on record. The total amount as recorded by the American Iron & Steel Association, was 4,123,535 net tons, an increase of 841,706 tons, or 26 per cent. over the production of 1889. The figures include 76,990 tons made by the Clapp-Griffiths process and a small amount by the Robert process.

Of the total production about 60 per cent. was made in Pennsylvania and a little over 20 per cent. in Illinois, the balance being furnished by other States.

The production of steel rails also showed a large increase. It amounted last year to 2,013,188 net tons, an increase of about 22 per cent. over the previous year; that is, nearly half the Bessemer steel produced was converted into rails. The increase in rail production was not quite as great as in the total steel production, the tendency last year being the same as in previous years, the proportion of steel used for other purposes having increased largely for several years past. Rail production has showed a very considerable gain, but has not kept pace

with the steel production, a fact which will not surprise any one who knows the continual increase in the application of steel for other purposes, especially in building and architectural work.

THE special bulletin issued by the Census shows in a striking way the increase in the production of anthracite coal. In the Census year 1889 the production was 40,665,000 long tons, against 25,576,000 tons 10 years ago. The total shipments of anthracite for the 10 years 1870-79 were 195,714,000, and for the 10 years 1880-89, they were 315,523,000 tons, showing an increase of over 50 per cent. in the average for the 10 years. Anthracite shipments are apt to be somewhat variable every year, owing to various causes which are well understood by the operators, so that the 10 years' average affords the best basis for comparison. According to the information collected by the Census there are 342 coal breakers and collieries in operation in the anthracite region, but as the average number of days' work is not over 200 in the year, it appears that the production is much below the possible maximum.

An addition to consumption, which is seldom taken into account, is the amount now drawn from the culm-banks of the various collieries. A considerable quantity of small coal and coal dust, which was formerly thrown away upon the bank, is now utilized, and the banks which have accumulated at many collieries are continually being drawn upon. In time, probably, all of this waste will be utilized, when the increasing cost of mining will make it profitable to put in the necessary appliances.

THE Census report of the Maryland coal product, which includes chiefly that of the Cumberland and adjoining regions, does not show much increase, the output for the last Census year being 2,940,000 short tons, against 2,229,000 tons 10 years ago. The production last year, however, was considerably less than in 1888, owing chiefly to lack of transportation. The coal of the Cumberland region is almost entirely used as a steam coal, owing to its peculiar qualities and high reputation, and most of it goes Eastward to tidewater, a great deal being used by sea-going vessels, while large quantities are carried by water to the Eastern States.

PROBABLY no industry included in the Census will show greater increase between the 10th and 11th Census than coal mining in Alabama. The preliminary report gives the total production of the State last year at 3,378,000 tons, while 10 years ago it amounted only to 324,000. A large part of this production was used at home by the furnaces and other manufacturing establishments, but considerable shipments were made to other States, and an increasing amount finds its way to tidewater for export, chiefly to the West Indies, or for steamship use.

There are three well-known coal districts in Alabama, the Warrior, the Coosa and the Cahaba fields, including a total area of about 8,700 square miles.

THE amendment to the Interstate Commerce law, which was passed by Congress at its last session, gives the Commission power to require the attendance of witnesses, production of books, and such other information from common carriers, subject to the law, as may be required to enable the Commission to perform its duties. Attendance of witnesses may be required from any place in the

United States to any designated place of hearing, and the orders of the Commission may be enforced by the United States Circuit Court. The Commission also receives the usual powers in relation to taking depositions, etc., the appointment of deputies and other necessary powers. This is an amendment which the Commission has been trying to secure for some time as necessary to the proper execution of its work.

THE process of railroad consolidation still continues, the latest step made being the lease of the Rome, Watertown & Ogdensburg Railroad by the New York Central & Hudson River Company. By this lease the lessee adds some 700 miles to its system, and secures control of a road which might be used to some extent as a competitor for traffic, though most of its business has always found an outlet over the Central's line. The lease seems to have been forced upon the Rome Company by the threat of a competing line for its most profitable traffic, but the terms are sufficiently favorable to the stockholders, who are guaranteed dividends equal to those they have been receiving lately, after a suspension of several years.

THE New York Central Company is credited with further plans for increasing its system, by controlling the New York, Ontario & Western, which has never been a profitable line. The Central might be able to work it to better advantage, and the union would do away with some competition. It is also reported that the Central would like to secure control of the Delaware & Hudson Canal Company's lines in Northern New York. That company is a strong one, however, and much of its stock is owned by wealthy and influential men. It has generally worked very harmoniously with the Central, and it is possible that the rumors of a lease are not well founded in fact.

THE success attained with the Weems electric railroad, on a somewhat imperfect experimental track with a small car, has led to the formation of plans for a larger road, supplied with an electric locomotive and cars of sufficient size to carry passengers. Mr. O. T. Crosby, the consulting electrician, who has prepared the plans, believes that with a properly constructed track and a locomotive of sufficient size a speed of 150 miles an hour can be reached without difficulty.

The experiments made with the small car on the Weems system seem to mark this as the most promising plan for fast travel on an electric road yet brought forward. The speed attained is limited by the defects of the track used, but it is said to have reached 115 miles an hour.

THE latest proposition for an addition to the Chicago Exposition is made by Mr. C. W. Hastings, of Kansas City, who proposes a tower 1,000 ft. in height. It is, however, to be directly the reverse of the Eiffel Tower, as instead of having a broad base and tapering gradually to the summit, the base is to be small, about 20 ft. in diameter, while at 800 ft. above the ground, the diameter will be nearly 200 ft. In other words, it will very much resemble the Eiffel Tower upside down. Its stability is to be secured by huge stays or guy-ropes stretched in all directions, and upon the summit will be a summer garden, gymnasium, dining-room, etc.

Should any of the guy-ropes give way, it is to be feared that this extraordinary structure would not be in a position

to support the hotel and other establishments on its top very long, especially if there were any wind blowing. Moreover, there are some slight difficulties in the erection, which Mr. Hastings does not seem to have taken into account.

THE Naval appropriation bill, as finally passed, makes provision for only one new vessel, a protected cruiser of 7,300 tons displacement and 21 knots speed.

Other special appropriations include \$100,000 for tests of armor; \$100,000 for traveling cranes at the New York and the Norfolk yards; \$136,889 for the new Naval Observatory, and \$25,000 for the naval militia.

THE bill authorizing the Government to guarantee \$100,000,000 bonds of the Nicaragua Canal Company failed to pass Congress, owing to lack of time. It will be brought forward again in the next Congress.

THE plan adopted for stirring up public opinion on the highway question by the Engineering Association of the South is to have short, pointed, practical papers, to be printed and widely distributed. This seems to be an excellent way; the greatest difficulty will be at the beginning—to secure suitable papers.

THE chief value and purpose of the diplomatic service of the United States is to help and forward its commercial interests abroad, and consequently its manufacturing interests at home. The State Department has done some very good work in this direction, and the consular reports which it issues contain much valuable information. The more credit is due to the Department for what it has done, when it is remembered that under our present system it has too often to make the best possible use of very inefficient agents.

Under these circumstances, it is not at all encouraging to find a person appointed to the very important position of Minister to China, whose sole recommendation is that he is a politician "out of a job." Personally the new minister's character may be unexceptionable, but he is certainly far from being fitted for a post which, beyond any other in our diplomatic service, requires a shrewd, capable, active man of affairs. China is just beginning, through many struggles, to recognize the necessity of building railroads, and of adopting modern methods of mining, modern appliances in manufacture, and modern ships. The process is a very slow and difficult one at best, but there is progress, and at this juncture the services of a capable man, with some knowledge of Chinese affairs and the national character, might be of inestimable value to American manufacturers and engineers. Such a man could be found; there are a few names that will suggest themselves to any one who thinks on the subject; but "politics" have been too much for the appointing power, and our interests must suffer accordingly.

THE Japanese Government has resolved upon a large increase of its navy, the policy being to promote shipbuilding at home as much as possible. Considerable additions have already been made to the navy, and the Japanese mercantile marine is growing rapidly, but the home shipyards are still insufficient in capacity to construct a num-

ber of war-ships. The programme recently adopted provides for 25 new ships, including battle-ships, fast cruisers and coast defense batteries. The first to be bought or built during the current year will be two armored cruisers and three torpedo boats, all of which will be procured in Europe, and a similar addition will be made every year for the next four or five years. These new ships will bring the Navy of Japan up to 75 vessels, of which about 40 will be of the most modern construction.

THE Navy Department has already sent out a call for bids for the construction of Cruiser No. 13, the only new ship authorized by Congress at the last session. The plans are not yet completed, but it is stated that they will follow closely those of No. 12, the fast three-screw cruiser now building at the Cramp yards, in Philadelphia. The new ship will have three screws, a sea speed of 21 knots an hour, and will be of 7,400 tons displacement. She will be a fast cruiser, with large coal capacity and consequent long cruising range, and with comparatively light armament. The bids will be opened in June.

THE "whale-back" steamer *Colgate Hoyt*, which was described and illustrated in our columns some months ago, has developed another good quality in addition to those already claimed for her by her builders. On her last trip down for last season her captain reports that she proved herself a first-class ice-breaker, the peculiar form of her bow working away and breaking up easily the ice which was forming rapidly on the lake as she came through.

The whale-back ships are to be tried on the ocean as well as on the lakes, one being under construction which is to be sent through the canals to the Atlantic. This boat will be employed in carrying iron ore from Cuba to the United States.

THE two steel steamships which were built last summer in the Wheeler Yard at Bay City, Mich., for the coasting trade, have been successfully brought down to Montreal and will soon be ready to take their places on the Atlantic. As they were too large to pass the St. Lawrence Canals, the novel plan was adopted of cutting them in two and sending them down in sections to Montreal, where the halves were joined together. The bulkheads were arranged with a view to this, and the trip was made without accident of any kind.

THE Intercontinental Railroad Commission is making arrangements for preliminary surveys of the proposed line through Central America, which is to connect the Mexican railroad system with the railroads of South America, and to form a link in the great Intercontinental line. Several parties will shortly be put in the field, and the Secretary of War has detailed a number of Army officers, who will be employed in this work under the general direction of the Commission.

THE latest accounts from Russia are to the effect that work is to be begun this year on the Siberian Railroad, and that six years are to be allowed for the completion of the work. This covers only the sections surveyed, of which a very full account has been given in the JOURNAL, leaving open the two long stretches covered by water navigation, which are to be replaced by railroad lines later. There is little doubt, however, that the western section, from

Chelabinsk to Tomsk, will be supplied with a railroad before the central section is finished, since the work of construction itself will show the difficulty of relying on a long and circuitous river line in that country.

#### THE CENTENNIAL OF PATENTS.

THE first American Patent Law, entitled "*An Act to Promote the Progress of the Useful Arts*," was signed by George Washington on April 10, 1791. In view of the results of this wise legislation it is proposed to celebrate the event by a series of public meetings to be held in Washington on April 8, 9 and 10, an announcement of which will be found on another page. An inviting list of eminent speakers is announced for that occasion, who will discuss the history and the advancement of the patent system and its influence on science, art and progress generally. The celebration will be profitable if it does nothing else excepting to elucidate to the public the extent to which the advancement and prosperity of the country and its people, has been and is due to our patent system.

The Constitution of the United States very wisely provided that Congress shall have power "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries." The wisdom of doing this is, however, still disputed by a great many people; and the patent system has many enemies in Congress and out of it. The recent discussion of the International Copyright Bill by our national legislators and in the newspapers, has revealed how confused the ideas of many people are with reference to property in ideas. More than thirty years ago Herbert Spencer wrote: "That a man's right to the produce of his brain is equally valid with his right to the produce of his hands, is a fact which has yet obtained but a very imperfect recognition." "The sense of property," it is said by an eminent writer on law, "is inherent in the human breast; and the gradual enlargement and cultivation of that sense, from its feeble force in the savage state to its full vigor and maturity among polished nations, forms a very instructive portion of civil society." The recent adoption of the International Copyright Bill, and a celebration of the beginning of the patent system, are certainly interesting and instructive epochs in the gradual enlargement and cultivation of the sense of property. Perhaps no fitter words could be found for promulgating the celebration of the anniversary of the signing of the first American patent law than those of Chancellor Kent in his "*Commentaries on American Law*," in which he says: "It has been found necessary, however, for the promotion of the useful arts, and the encouragement of learning, that ingenious men should be stimulated to the most active exertion of the powers of genius in the production of works useful to the country and instructive to mankind, by the hope of profit, as well as by the love of fame or a sense of duty. *It is just that they should enjoy the pecuniary profits resulting from mental as well as bodily labor.*"

In other words, the Government said, in effect, one hundred years ago, that, in order to stimulate invention, it would secure to inventors, for a limited time, the right to the exclusive use and profit of their productions and discoveries. Quoting Herbert Spencer again, "there are philanthropic and even thinking men who consider that the valuable ideas originated by individuals—ideas which

may be of great national advantage—should be taken out of private hands and thrown open to the public at large." This spirit has manifested itself very strongly among the granger farmers of the West, and is common among some manufacturers, and frequently crops out in attempts at legislation. There are many people who hold that to allow the discoverer of any new or improved mode of production to have the exclusive use of his invention is an injustice. The question is constantly recurring, Why should a person who first invents or discovers a new and useful art, machine, manufacture, or composition of matter, have rights secured to him which are denied to another, who is the second inventor, and who may invent or discover the same thing an hour, a day, or a year later? The answer to this is, that unless such rights are secured to inventors they will stop inventing, or, in the language of the eminent author from whom we have already quoted: "Just in so far as the benefits likely to accrue to the inventor are precarious, will he be deterred from carrying out his plans. 'If,' thinks he to himself, 'others are to enjoy the fruits of these wearisome studies and these numberless experiments, why should I continue them? If, in addition to all the possibilities of failure in the scheme itself, all the time, trouble and expense of my investigations, all the chances of destruction to my claim by disclosure of the plan, all the heavy costs attendant upon obtaining legal protection, I am liable to be deprived of my right by any scoundrel who may infringe it in the expectation that I shall not have money or madness enough to institute a chancery suit against him, I had better abandon the project at once.' And although such reflections may often fail to extinguish the sanguine hopes of an inventor, although he may still prosecute his scheme to the end, regardless of all risks, yet after having once suffered the losses which, ten to one, society will inflict on him, he will take good care never again to enter upon a similar undertaking. Whatever ideas he may then or subsequently entertain—some of them most likely valuable ones—will remain undeveloped and probably die with him. Did mankind know the many important discoveries which the ingenious are prevented from giving to the world by the cost of obtaining legal protection, or by the distrust of that protection if obtained—were people duly to appreciate the consequent check put upon the development of the means of production—and could they properly estimate the loss thereby entailed upon themselves, they would begin to see that the recognition of the right of property in ideas, is only less important than the recognition of the right of property in goods."

In all probability many of the most important inventions which have been made, and which are used in recent years, would either never have been developed, or would have been delayed for years had there been no patent laws to protect the inventor while he was working out his ideas. Among these are the Bessemer processes of making steel, continuous brakes, interlocking and block signals, to say nothing of the electric telegraph, the locomotive itself, and thousands of minor inventions through or by which the whole art of railroading has been built up. Without steel rails and tires the cost of carrying freight would be very much increased, and the perfection of the signals and brakes alone makes the immense traffic of some of the crowded lines possible, or at any rate makes it possible with comparative safety.

The question is constantly recurring, Why should a

person who first invents or discovers a new and useful art, machine, manufacture, or composition of matter, have rights secured to him which are denied to another who is the second inventor, and who may invent or discover the same thing an hour, a day, or a year later? It would be well if the critics of the patent system would consider the probable effect of repealing the patent laws, and the result which would follow if the Government should refuse to secure to inventors the exclusive right to their inventions. The purpose of the patent law is to "*stimulate ingenious men,*" and that it accomplishes its purpose the weekly issue of patents testifies.

A preliminary programme of the celebration sets forth that distinguished speakers will show the influence which invention has had in Household Economy; Medicine, Surgery, and Practical Sanitation; Electrical Science, Material Development of the United States; Railroads and other means of Intercommunication; Chemistry and Physics; the New South; Implements and Munitions of Modern Warfare; Telegraph and Telephone; the Steam Engine, Agriculture, and the Relation of Invention to Labor.

In the interest of the patent system, it is to be feared that sufficient evidence to prove the converse of the general proposition, embraced by these subjects, will not be brought forth. That is, the opponents of the patent system will say, all this development and progress is not the result or consequence of our patent laws, but it has been evolved by the forces of our civilization, and this advancement would have occurred as rapidly without patents as with them. It is difficult, however, to conceive of any other motives, excepting the prospect of the enjoyment of pecuniary profits, which would be sufficient to lead most persons to suffer the ills which most inventors must endure. "Fame," or "a sense of duty" might lead some to invent, and others might engage in the somewhat expensive and absorbing diversion from a mere love of it; but few would be sustained to endure the rebuffs, the failures, the discouragements, the expense, the ridicule often, the loss of time, and the uncertainty which nearly all who carry an invention to a successful issue, are subjected. A little experience of the difficulties which must be encountered would soon cool the ardor of the most ingenious men, if the exclusive right to the use of their inventions were not secured to them. It is a very common experience for persons of an inventive turn of mind to conceive of some new idea, and to discover that it is old, or has been anticipated, and therefore is not patentable. The alacrity with which such conceptions are abandoned is strong evidence in favor of patent laws.

It is probable that few persons have any idea of the extent to which the success of a new invention is dependent upon the zeal, enthusiasm, faith, hope and perseverance of the inventor. It is rare that a new machine or discovery springs full-fledged, or, rather, full-pinioned, from the mind or hand of its author. Usually his offspring is a puny and ungainly chick, which requires to be long and carefully nourished with paternal hope and affection, and needs time for development before it is of much use. It is only a parent who will give such care, and without it any infant is likely to perish.

It must be remembered, too, that the world is not eager in welcoming new inventions. Generally the inventor must fight his way. He must overcome ignorance, selfishness, and the depressing mental inertia which blocks the way of all progress, and will not move excepting under the

blows of some intellectual battering-ram. It is in this direction that the inventor does much of his most useful work. He necessarily becomes a sort of missionary to preach progress, and convert those who do not believe in it; and many a valuable discovery would never be adopted were it not for the efforts of its discoverer in teaching and convincing others of its value. Few men are sufficiently unselfish to engage in such work without the hope of pecuniary profit, and this is supplied by our patent laws.

### HIGHWAY ROADS.

THE agitation of the highway question is active in Tennessee, where it has been taken up by the Nashville Commercial Club—a body of considerable weight and influence—and active measures have been taken to impress upon the people the value of better roads. Much of this activity is due to the persistence and intelligence of one man (Professor O. H. Landreth, of Vanderbilt University), and his success is an instance of what may be accomplished in this direction. After all, the advantages of good roads are so manifest, that it seems as if all that is really necessary is to make the people at large understand them, in order to secure at least a beginning of the needed reform.

The bill which the Nashville Club has prepared for submission to the Legislature has as its basis the adoption of the county instead of the road district as the highway unit, and this is supplemented by a system of State supervision. That the larger district is necessary to secure proper management there is little doubt. The county can afford to secure the services of an engineer where the little road district must depend on such time as an overseer can spare from his other work; moreover, even if he wants to do well—which is not always the case by any means—he is usually unacquainted with the proper methods of building and maintaining roads. Too often the district officer cares only to get along with as little trouble as possible, and to keep on good terms with his neighbors by making their road tax as light as possible.

The great trouble is just here—to make farmers and land-owners understand that their nominal road tax, under any system, is a trifling one compared with the continual tax imposed on them by bad roads. They do not pay this in money, but it is none the less real and onerous. There is hardly a county in the United States where a good road system would not increase the value of farming lands; and but little calculation is needed to show how much an increase of 20, or even 10 per cent. in the load which his team can haul over a road would benefit the farmer. This is a gain which can be realized every day in the year almost, so that its total must be considerable even for the smallest farmer.

Some advance in the highway question is to be noted elsewhere than in Tennessee. In New York a bill to carry out Governor Hill's recommendation of a system of State roads is before the State Legislature, and has a fair chance of passing. In New Jersey the county system is beginning to show its advantages in those counties where it has been adopted, so that others are preparing to follow their example. In Pennsylvania the agitation continues, and some action may be taken this year on the recommendations made by the Road Commission.

Agitation is needed everywhere; and much can be accomplished by local bodies like the Nashville Commercial

Club. But this must be supplemented by instruction in the best methods of building and maintaining roads; not theoretical, but practical, with regard to local conditions and the greatest economy consistent with good work. This can be done in many cases by the local engineering associations; and there is no more useful work which they can undertake than to follow the good example set by the Engineers' Society of Western Pennsylvania, and the Engineering Association of the South.

### NEW PUBLICATIONS.

THE DURABILITY OF BRICK PAVEMENTS. By Professor Ira O. Baker. (T. A. Randall & Company, Indianapolis; price 25 cents.)

Engineers in Eastern cities, where stone is accessible and usually cheap, do not realize to how great an extent brick is used for street pavements in the Mississippi Valley and other parts of the West where suitable stone is not to be had, or where it must be brought long distances and is, therefore, costly. In this little book Professor Baker has given the results of a number of experimental tests made by him with a view of determining the value of brick for street pavements, as compared with stone, wood and other materials. The results were more favorable to brick than had been expected; but they agree with those obtained by practical tests in St. Louis and other cities.

THE COAL TRADE. *A Compendium of Valuable Information Relative to Coal Production, Prices, Transportation, etc.* By Frederick E. Saward. (*The Coal Trade Journal*, New York.)

This is the eighteenth number of Mr. Saward's valuable annual, which is what its title indicates, a valuable compendium of statistics relating to the coal trade of this country, with incidentally a good deal about the same trade in other countries.

COMPOUND LOCOMOTIVES. By Arthur T. Woods, M.M.E. (R. M. Van Arsdale, New York.)

This book is a republication of a series of articles which first appeared in the *National Car and Locomotive Builder*, in the preparation of which the Author says it has been his aim "to combine the description of the various forms of compound locomotives which have been actually used, with so much of the theory of the design of compound engines as would seem to be directly applicable to locomotive practice."

"An effort has been made to present an unprejudiced analysis of each type, and to point out such advantages and disadvantages as are apparently clearly demonstrable, while carefully avoiding matters of individual preference."

This purpose the Author has very fully accomplished; and he has made a little book of 167 pages, from which more information on this subject can be obtained than from any other one source. The literature on the subject is scattered very widely, and is difficult of access to the ordinary reader, so that a compilation, or rather condensation of it, like the book before us, is very much needed. In doing his work, however, the Author did more than compile and condense—he digested his material, and has presented it in clear and concise style, so that any one with an elementary knowledge of algebra can read it understandingly.

The first chapter treats of the theory of compound engines; the second of the design of two-cylinder compound locomotives; the third of the Worsdell von Borries System; the fourth of the Mallet two-cylinder type; the fifth of the Lindner

type; the sixth of the economy of two-cylinder engines; the seventh of three-cylinder engines; the eighth of the starting power and performance of three-cylinder engines; the ninth of four-cylinder receiver engines; the tenth of four-cylinder tandem engines; the eleventh contains a comparison of types, and the twelfth and last chapter is on American compound locomotives.

There is little that is new in the book; but this is not written in disparagement of it, as it is intended, apparently, only as a summary of the existing knowledge on the subject.

A table opposite page 82 shows, from tests with simple and compound locomotives in different parts of the world, an economy in fuel consumption varying from 13 to 24 per cent. The highest percentage of saving was for a six months' trial of two engines in Saxony, working with the same boiler pressure—176.4 lbs. in each engine, which otherwise were of almost identical dimensions. In another case the pressure in each engine was 120 lbs., with a saving of 13.5 per cent.

In speaking of the Webb compound locomotive the Author says: "The weak features in its design, from an American point of view, have been charged to the compound system in general, and its successes credited to the personal superintendence or 'nursing' of the inventor. That the latter is a factor which is at least worth considering in estimating the value of reported results, should be evident to all who are familiar with the management of steam machinery." We are inclined to think that this remark should apply to the recorded performances of all engines whatsoever—simple as well as compound—and not to the Webb engine alone.

There is much cumulative testimony, showing the economy in fuel consumption of compound over simple locomotives, but not more than there was a few years ago to show the economy of narrow-gauge railroads over those of standard gauge. It was the friends of the narrow gauge who testified then, it is the friends of the compound locomotive who are giving evidence now. The arguments, and the gauge, which were then believed in so earnestly, have both been narrowed into nothingness. It may be well, perhaps, to sift the evidence in favor of compound locomotives very carefully now, rather than to be led into a demonstration as expansive as that which was needed to refute the narrow-gauge delusion.

**VALVE GEARS.** By H. W. Spangler, P. A. Engr., U. S. Navy; Whitney Professor of Mechanical Engineering in the University of Pennsylvania. (John Wiley & Sons, New York.)

The Author of this treatise says that it was prepared for class use, which accounts, perhaps, for the liberal employment of mathematics in its pages. It may be well for purposes of discipline and training of students, to explain subjects by methods more difficult to understand than the matter explained, but to a person accustomed to practical work it seems a circuitous way of reaching an end to which there is a more direct and shorter road. Take, as an example, the following formula, which is given on page 54, for calculating the distance a valve, moved by a Stephenson link, travels from its middle position:

$$x = \frac{r}{2c} (2 \frac{c^2 - u^2}{g} \cos. \delta \cos. \omega + 2c \sin. \delta \cos. \omega + 2u \cos. \delta \sin. \omega) \\ = r \cos. \omega (\sin. \delta + \frac{c^2 - u^2}{cg} \cos. \delta) + \frac{ur}{c} \cos. \delta \sin. \omega.$$

Would any engineer of experience ever use such a method to ascertain the distance a valve has moved?

Then two very simple movements of the valve are explained by means of the Zeuner diagram, which is not always easy to understand. Besides, in one place, it is admitted that in deducing the equation for the Zeuner diagram, certain approximations have been made which cause the diagrams to be more or less inexact. In other words, after puzzling the student with difficult elucidations, it is admitted that neither are correct.

The book treats of different kinds of valves and methods of designing them—the Stephenson link, the Gooch motion, the Allen and Fink motions, radial gears, including Hachworth's, Marshall's, Angstrom's and Joy's; double and gridiron valves, Polonceau's, the Buckeye, Meyer's and Guinette's gears, and Bilgram's, Releaux and elliptical diagrams.

The book gives a description of the construction and principles of action of all these different kinds of gears, which doubtless will be useful to those students who are well up in mathematics. To most practical men who are not mathematicians, the explanations and solutions will be hard to understand. In nearly all cases, probably, books are written and published to sell. Whether this was the object or not in issuing the one reviewed here is not apparent from the copy before us; but there can be little doubt that its field of usefulness would have been much wider if the subjects discussed had been treated graphically also, and if difficult mathematics had been ignored.

The book is deficient, too, in not explaining more fully what should be accomplished by a valve-gear. To get a complete understanding of this, valve-gear must be studied in connection with, or rather in relation to, indicator diagrams. In doing this it should be known first what kind of indicator diagrams ought to be produced by a valve gear. In other words, the first question to be considered is, what should be the forms of indicator diagrams to produce the best results in using steam in engines of different kinds, and next, how should the gear be designed and proportioned to produce such diagrams?

Considerable space is devoted to explaining how the slip of the link-block may be reduced. This slip, it is said, is objectionable if excessive, which may be doubted. As a matter of fact, the slip of the block in a Stephenson or Gooch link, and, probably, in other gears, may be a very useful means of modifying the action of the gear in order to accomplish certain desirable results; and if there are ample bearing surfaces, it really matters very little whether the slip is much or little, excepting so far as the action of the gear on the motion of the valve is concerned. The use which may be made of the slip of the block is not explained.

The book before us will be very useful as a class book in the hands of its Author or other teachers, but it is rather a book for the study than an elucidation of the subject of valve-gears for practical men.

**FOURTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION.** For the Year 1890. (Government Printing Office, Washington.)

The fourth report of the Interstate Commerce Commission is necessarily, to some extent, a repetition of what has been said before. The work of the Commission is varied, but, after all, it presents a certain monotony, and it is necessary to present the same subjects year after year, and to repeat the same recommendations in order to secure the attention of Congress. That body is too apt to neglect modest claimants and, like the unjust judge in the parable, listen to those who weary it with constant asking. Four years' experience with the interstate commerce law has naturally shown its weak points and the provisions which need to be changed or abolished, but it is no easy matter to secure these changes from the legislative body.

The statement of the work done for the year, and of the practical workings of regulation, shows that the Commission is a hard-working body, and has little opportunity for idleness.

Apart from this statement, the subjects treated of in this report are Rate Wars and Rate Cutting; Reasonable Rates; Uniform Classification; Long and Short Hauls; State Regulation; Foreign Regulation of Railroads; Ticket Brokerage; Through Routes and Through Rates, and Payment of Commissions on sales of Tickets.

The report recommends some needed amendments to the act, and gives a condensed statement of the methods adopted in the different States. Appended to the report is an account of the Conference of Railroad Commissioners, and also a chapter on Railroad Regulation in Foreign Countries.

HANDBOOK OF THE AMERICAN REPUBLICS. *Bulletin No. 1 of the Bureau of the American Republics, January, 1891.* (Washington; Government Printing Office.)

One of the results of the Pan American Conference at Washington last year has been the establishment of the Bureau of the American Republics, which has its headquarters in Washington, and the object of which is to collect and distribute information of interest and value to the commercial public of American countries, the end in view being the improvement and development of commercial intercourse.

The present Bulletin No. 1 must be regarded as preliminary, and in fact an introduction to the series. It is what its leading title indicates, a handbook of condensed information as to lines of communication between the United States and the Republics of Central and South America; commercial systems and trade customs of the different countries; commercial laws and tariff systems; productions, imports and exports; present condition of trade; coinage and monetary systems; consular regulations; and a variety of geographical information.

Necessarily in a volume where condensation and brevity is an object there is no opportunity for literary display; but the information here is clearly and plainly given. Its value is much increased by a very full index. The statistics and other information are brought up to the latest possible date. Altogether the book must be a very useful one to those for whom it is intended, and it is an excellent beginning of a promised series.

#### TRADE CATALOGUES.

*The Johnson Railroad Signal Company's Catalogue: Rahway, N. J.*

The word catalogue does not indicate correctly the character of this volume. An elementary and abridged treatise on railroad signaling would describe it better. The object of the pamphlet, as stated in the introduction, is "to draw attention to the appliances of the Johnson Railroad Signal Company, and to give a few hints on signaling in general."

It explains very briefly the best methods of protecting switches, side-tracks, grade-crossings, draw-bridges, single and double-track junctions, and passenger stations with signals. These explanations are followed by remarks on the arrangement of tracks, the number of levers which should be used, selectors, dwarf signals, and a description of the Johnson interlocking machine.

The pamphlet will be found very useful to all who are interested in signaling, but especially to those railroad men who have little or no knowledge of interlocking signals. It can be read in less than an hour, and it contains the recommendations of one of the most expert signal engineers in this country.

The office of the Johnson Signal Company is at 146 Broadway, New York; the works are at Rahway, N. J.

*The Norwood Car Replacer Company, Baltimore: Illustrated Catalogue.*

*Rosendale Cement; its Uses and Modes of Application: by Ludlow V. Clark, Jr. New York; the Lawrence Cement Company.*

*Treatise on Cement: by M. Albert Scull. New York; the Lawrence Cement Company.*

#### BOOKS RECEIVED.

*Proceedings of a National Convention of Railroad Commissioners held at the Office of the Interstate Commerce Commission, Washington, D.C., March 3 and 4, 1891.* Washington.

*Annual Report of the State Board of Arbitration of Massachusetts, for the year 1890.* Boston; State Printers.

*Annual Report of the Board of Regents of the Smithsonian Institution.* Washington; Government Printing Office.

*Annual Report of the Smithsonian Institution; the United States National Museum.* Washington; Government Printing Office.

*The American Patent System; a Practical Guide to the Inventor and to the Investor in Patents; by D. Waller Brown.* New York; published for the Author.

*Reports of the Consuls of the United States to the State Department: No. 123, December, 1890.* Washington; Government Printing Office.

*Eighth Annual Report of the Board of Railroad Commissioners of the State of New York, for the Fiscal Year ending June 30, 1890.* Albany, N. Y.; State Printer.

*Occasional Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The papers included in this issue are Steam on Common Roads, by John McLaren; Mental Calculation, by W. Pole; Tramway Permanent Way, by James More, Jr.; Abstract of Papers in Foreign Transactions and Periodicals.

*Transactions of the Denver Society of Civil Engineers and Architects: Volume I, 1890.* Denver, Col.; published for the Society.

*Nineteenth Annual Report of the Superintendent of Water-Works, Bay City, Mich.: E. L. Dunbar, Superintendent.* Bay City, Mich.; published by the City.

*Annual Register of the United States Naval Academy, Annapolis. Academic Year, 1890-91.* Washington; Government Printing Office.

*Cornell University, College of Agriculture: Third Annual Report of the Agricultural Experiment Station.* Ithaca, N. Y.; published by the University.

*Municipal Ownership of Quasi-Public Works: by Allen R. Foote; printed for the Author.* This is a reprint of a paper read by Mr. Foote before the Washington Branch of the American Economic Association.

*Reform in Railway Construction: by Oberlin Smith.* Reprinted from the *Forum* for the Author.

*Annual Message of Chas. M. Howe, Mayor of the City of Passaic.* Passaic, N. J.; printed for the City.

*Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending September 30, 1890.* Washington; Government Printing Office.

#### ABOUT BOOKS AND PERIODICALS.

APART from teachers and others whose interest in the subject is professional, there are certainly a large number of persons in this country who take much interest in geographical studies. The periodicals issued by the geographical societies contain many valuable papers, but these are often too long for a man who has his daily work or profession to attend to; and their circulation is necessarily limited to the members of the societies and their immediate circle.

To meet this want, Messrs. M. & J. C. Goldthwaite, of New York, began in January the publication of GOLDTHWAITE'S

GEOGRAPHICAL MAGAZINE, a monthly, intended to present new facts ascertained; descriptions of new apparatus and methods; accounts of explorations, surveys, etc., and other geographical notes. These are given in condensed and popular form, and the articles are well illustrated. The Messrs. Goldthwaite have been for years in the geographical publishing business, and are consequently familiar with the subject and its general range, while they have means of acquiring the latest information.

The three numbers of our geographical contemporary which have been thus far issued are excellent, and give promise of future usefulness in their chosen field. The articles are varied in subject and treatment, but all are short, and show marks of careful condensation. A number of them are illustrated. Mention of them separately would require more space than can be allowed here, but one of the most interesting is the leading one, on the Mapping of the World. There are in the magazine 72 pages of reading matter, besides cuts, the page being slightly larger than that of *Harper's* or the *Century*. The typographical execution is good, and altogether the magazine deserves the success which we hope and believe that it will secure.

The February number of the JOURNAL of the American Society of Naval Engineers contains articles on Forging Steel Crank Shafts, by Assistant Engineer A. M. Hunt; Fitting the Crank Shaft of the *Newark*, by Passed Assistant Engineer A. C. Engard; Causes of the Vibrations of Screw Steamers, by Assistant Naval Constructor D. W. Taylor; Register for Speed Trials, by Assistant Engineer W. D. Weaver; Trial of the *Concord*, by Chief Engineer R. B. Hine; Trial of the *Newark*, by Assistant Engineer L. D. Miner; Experiments with the Belleville Boiler, by C. A. Blomberg. In this number also, Chief Engineer Isherwood criticises the recent paper on Analysis of Steam-Engine Trials, by Assistant Engineer W. H. Alderdice, and the author defends his position against Mr. Isherwood's criticisms.

There will be found in BELFORD'S MAGAZINE for March the usual variety of lighter matter, and several more solid articles. This is the only one of the prominent magazines having a decided political cast, and its articles on political topics are generally moderate in tone and well considered in argument, making them worth reading, whether we agree or disagree with the conclusions drawn by the writers.

The December number of the JOURNAL of the New England Water-Works Association has papers on Water Supply for Small Cities in the West, by Wynkoop Kiersted; Filtration of Natural Waters, by Professor Thomas M. Drown; Variations of Weather and Climate as Affecting Water Supply, by Professor William R. Niles. There are also discussions on several topics of interest to water-works engineers.

The military article in OUTING for March describes the training of the British Red-coat, and is well illustrated. Shipbuilders should study Captain Schuyler's paper on the Evolution of the Yacht. Summer in the Azores and Winter in North Carolina, find descriptions in this number, while canoeing, photography, fishing, and duck-shooting all have their share of attention.

The November number of the TECHNOLOGY QUARTERLY has an article on the Changes of the Year, by General Francis A. Walker, besides a number of other papers of technical interest. This is largely a chemical number, the longest articles being on questions relating to technical chemistry, although other subjects are touched on also.

The South American paper in HARPER'S MAGAZINE for March describes the city of Buenos Ayres; it is accompanied by a number of illustrations. Nationality in Music is a curious study, and might be enlarged to show how the musical tendencies of a people complement its more material qualities. Among the lighter articles, a story by Brander Matthews illustrates the capacities of a modern "vestibule limited" train.

The fourth article on American Industries, which is given in the POPULAR SCIENCE MONTHLY for March, continues Mr. Durfee's series on Iron Working, and is on rolling and forging iron. Professor Ordway's paper on Non-conductors of Heat, is an excellent one, as is also that of Relative Value of Cements, by Professor C. D. Jameson and Hubert Remley. Adaptation to Climate, by M. St.-Yves Menard, and the Cultivation of Sisal in the Bahamas, by J. I. Northrop, are interesting articles.

The January number of the SCHOOL OF MINES QUARTERLY has papers on the Coal-Fields of Montana, by Walter H. Weed; on the U. S. Geological Survey, by H. M. Wilson, besides several other papers of special value to mining engineers. The News Bulletin ought to be of much interest to the Alumni of the School.

In its March number the ECLECTIC MAGAZINE has an excellent selection of articles from the foreign magazines. Among the more noticeable are Englishmen in Africa, from the *Contemporary Review*; Trade Unionism, from the *Nineteenth Century*; Weighing the Stars, from the *Gentlemen's Magazine*, and the Cost of a London Fog, from *Leisure Hours*. This magazine is an excellent one for all who wish to know something of the foreign periodicals, but have not the time or opportunity to read the originals. Its selections are generally judicious, and are made to show the general current of thought and writing abroad.

The leading paper in the March number of the JOURNAL of the Military Service Institution is on Artillery Administration, and is by the late General Henry J. Hunt, whose distinguished service as Chief of Artillery of the Army of the Potomac are well remembered. Other articles are on Musketry, by Captain Chester; on Military Gymnastics, by Captain Foote; on the Increase in the Number of Cadets, by Professor Michie, and on the Power of the Senate, by General Foy. The usual variety of reprints and translations completes a very interesting number.

The latest quarterly number of the PROCEEDINGS of the United States Naval Institute is devoted to the Armor Tests at Annapolis. There is a short introduction by Edward W. Very, and the report of the Board is given in full, with numerous illustrations. These tests were of high value, and nothing of greater interest could have been presented at the present time.

In the March number of SCRIBNER'S MAGAZINE, Samuel Parsons, Jr., writes of the Ornamentation of Ponds and Lakes, of which he is well qualified to speak, from his long experience as Superintendent of the New York parks. Mr. M. B. Kerr describes Mount St. Elias and its glaciers, and Sir Edwin Arnold's papers on Japan are continued. The views of Mount St. Elias are very striking, and praise must be given also to the illustrations in the paper on London and American Clubs, which are excellent; those of the Japanese paper, however, are not as clear in execution as the designs deserve.

The contents of the LEHIGH QUARTERLY for January include Lehigh University Precise Triangulation, by Henry S. Jacoby; Development of the Coal and Timber Lands of Southeastern Kentucky, by F. E. Fisher; Emery Wheels, by J. S. Heilig; a series of short articles on Civil Engineering, including advice to young engineers, by Alfred P. Boller, O. Chanute, Horace Andrews, W. Barclay Parsons, and F. C. Osborn.

As usual, the March ARENA is full of discussions of social and other topics. Among these may be mentioned Professor Buchanan's paper on Nationalization of the Land, and Rabbi Schindler's on Immigration. The description of a curious people, whose origin is unknown, but who still survive in an out-of-the-way corner of Tennessee, which is written by Miss Drumgoole, is a valuable contribution to minor history. The ARENA is combative and aggressive, and no one can read it without finding some new ideas.

## A NEW BRIDGE-GUARD.

(M. J. W. Post, in *Revue Generale des Chemins de Fer.*)

THE importance of some device to prevent injury to bridges from the derailment of cars on the approaches, hardly requires discussion. The expense of any such device is usually small in comparison to the total cost of the bridge, and the greater the number of trains, the less should such cost be considered.

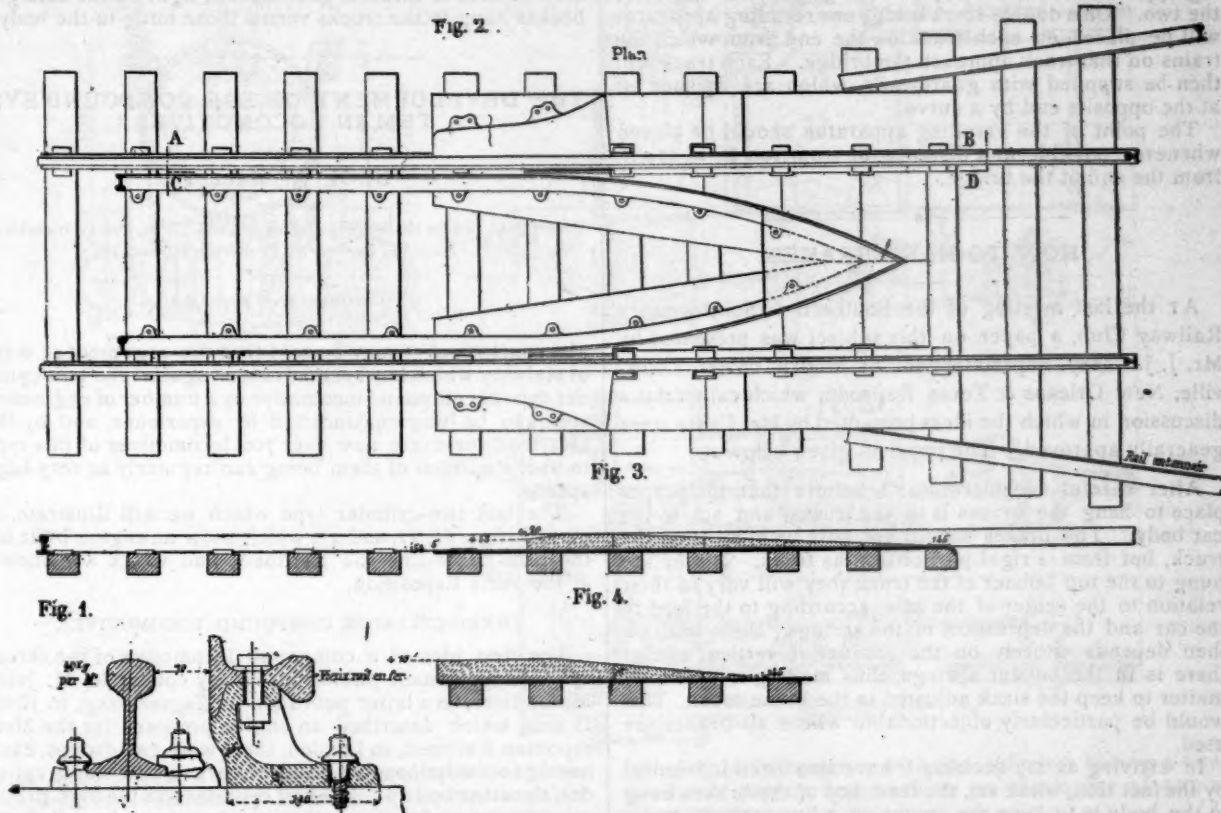
A bridge-guard, or rerailing device, should meet certain general conditions, which may be summed up as follows :

1. It must be so arranged that it cannot in any way cause the derailment of a car. It should, therefore, leave abundant room for the passage of wheels, making all allowances for the condition of wheels and tires when

Seven ties are placed in a thick bed of large gravel ballast, and on these are placed a floor of steel plates, fastened to the ties by bolts, as shown in fig. 2. The rerailing apparatus is mounted on this floor. The plates outside of the rails can easily be removed when the ties are to be tamped.

In a vertical direction, the derailed wheels are gradually brought up to a height where they can take the rail again by inclined planes outside and inside the rail ; these planes are formed of blocks attached to the plates, the thinner ones being forged and riveted, the heavier ones cast and bolted. These are shown in section in figs. 3 and 4 ; fig. 3 is a section on the line *C D*, fig. 2, inside the rail, and fig. 4 is a section on the line *A B*, outside the rail.

A derailed wheel which strikes this plane between the rail and the center of the track, running from *D* toward *C*, on the flange of the wheel, at the point where the hori-



BRIDGE-GUARD IN USE ON THE DUTCH STATE RAILROADS.

badly worn, as well as when new. Account must also be taken of the occasional use of cars from other roads.

2. It must not touch the weak points of a derailed car, and must be so arranged as to come in contact with the running gear only.

3. It must direct the wheels of a derailed car back upon the track without violent shocks, either in a horizontal or a vertical direction, and must bring them back before they reach the bridge.

4. It must keep on the track during the passage of the bridge cars which may have been derailed from any defect.

5. It must be constructed of durable materials, and in such a way that it will not be likely to fail when needed.

6. It must have no very heavy pieces, so that its putting in place, repair, etc., can be easily done by an ordinary track gang.

7. It must permit the tamping of the ties.

8. It must be cheap to make, to put in place, to keep in order and to renew. In other words, it must be easy to handle, and of small cost.

The accompanying illustration shows an apparatus which is in use on the Netherlands State Railroads, and which, it is believed, will meet all these requirements. It is very clearly shown in the engravings.

zontal distance, fig. 2, between the rail and the guard-rail becomes too small to permit the passage of the widest tires—say 6 in.—is already at the top of the incline plane, that is, about 0.8 in. below the top of the rail. As the depth of the flange may vary from 1 in. to 1.38 in., the tread of the wheel will be at least 0.2 in. above the top of the rail. The plane then descends slightly, as shown in fig. 3, until the tread of the wheel begins to bear on the rail.

On the inside of the rail the blocks are from 2.8 in. to 4 in. distant from the rail, so as to give free passage for the flanges of those wheels which remain on the track.

A derailed wheel, which reaches the apparatus outside the rails, rolling from *B* toward *A*, will mount the plane, traveling on the flange. The summit of the inclined plane might be made the same height as the rail, if it were necessary to provide only for new rails and new tires ; but to allow for worn rails and tires it is made 0.4 in. lower than the top of the rail.

In a horizontal direction one wheel on each axle of a derailed car is directed toward its rail by a guard-rail, which ends in a point in the center of the track, as shown in fig. 2, and which, to meet condition No. 4, is carried the whole length of the bridge, leaving a space of 2.8 in. to permit the passage of the wheel flanges. This guard-rail is composed of old rails bolted to chairs, as shown in section in

fig. 1. The points of the guard-rails are joined by a heavy plate. In view of the space allowed, and of the maximum wear of rails permitted, the top of the guard-rail is 1.4 in. above the top of the rail; at the point it is brought down to 0.43 in. below the top of the rail, to meet condition No. 2.

In a case where a car is so far off the track that one of its wheels would strike the rerailing apparatus beyond the center of the track, the tendency would be to throw the wagon entirely off the rails. To avoid this, which indeed cannot often happen, there are placed outside of the track two rails, inclined like the mouth of a funnel, as shown in fig. 2, which will guide the wheel in the desired direction, so that it will strike the guard-rail and be turned toward its own rail.

A single-track bridge, where trains run in both directions on the same track, will, of course, require the rerailing apparatus at each end, and the guard-rails will unite the two. On a double-track bridge one rerailing apparatus will be placed on each track on the end from which the trains on that track approach the bridge. Each track will then be supplied with guard-rails, which are finished off at the opposite end by a curve.

The point of the rerailing apparatus should be placed whenever possible at a distance of from 100 ft. to 170 ft. from the end of the bridge.

#### HOW TO HANG BRAKES.

At the last meeting of the Southern & Southwestern Railway Club, a paper on this subject was presented by Mr. J. J. Casey, Superintendent of Motive Power, Louisville, New Orleans & Texas Railroad, which called out a discussion in which the ideas presented by Mr. Casey were generally approved. The paper is given below:

After careful consideration, I believe that the proper place to hang the brakes is to the trucks, and not to the car body. The brakes should not only be hung from the truck, but from a rigid portion of the truck. If they are hung to the top bolster of the truck they will vary in their relation to the center of the axle, according to the load in the car and the depression of the springs; their position then depends entirely on the amount of vertical motion there is in the bolster springs, thus making it a difficult matter to keep the slack adjusted in the brake-rods. This would be particularly objectionable where air-brakes are used.

In arriving at my decision I have also been influenced by the fact that, when set, the tendency of the brakes hung to the body is to keep the trucks on a line with the body, instead of with the track. On improperly constructed curves, or bad track, this must necessarily be a source of accident, since the relations between the trucks and the car body are not compensating; in other words, the body will not allow the trucks to accommodate themselves to the variations in the track as would be the case if the brakes were hung from the truck.

Brake shoes should engage the wheel as near a central line as practicable, having the greater portion of the shoe below the center line of axle. If hung too low the brake shoe on one end of the truck (depending, of course, on the direction in which the car is moving) will form a wedge in addition to the adhesion given to it by the rod; the result is slid wheels. My experience would seem to show that there is very little difference, as regards safety, between brakes hung to the body of the car and brakes hung to the truck; this is due, I think, to the fact that no records on the subject are available.

Another point to be considered, one that does not seem to have been touched upon, is that hanging the brakes to the body materially shortens the life of the car. The car bodies are built, as a rule, to carry a certain load; no provision is ever made for the additional strain that is put on them by the braking power. This strain is considerable, and every one knows it is very irregular, and must necessarily be very destructive to the body, owing to the fact that

those strains are at least five feet from the center of the transom, this of itself giving considerable leverage. I do not consider it to be more expensive to maintain brakes hung from the trucks than those hung from the body. It is a very rare occurrence for us to have cars in our shop requiring repairs to inside brakes.

When brakes are hung to the body, I have noticed frequently that sills have been split and otherwise damaged in wrecks on account of the trucks leaving their place and being held to the body by the brake hangers only; something has to give way, and usually it is the sills.

This subject is of great importance, and should not be passed over lightly. There is a good deal that might be said, and I trust that it will have one effect—to cause members of this club to look more closely at the matter in the future. Possibly, some time later on this subject may be brought up again, when a great many of our members may be able to throw a good deal of light on the safety of brakes hung to the trucks versus those hung to the body.

#### THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

BY M. A. MALLET.

(Paper read before the Société des Ingénieurs Civils, Paris; translated from the French by Frederick Hobart.)

(Continued from page 112.)

In conclusion, it may be said that the argument of want of stability which has been advanced against the two-cylinder type of compound locomotive by a number of engineers, seems to be fully contradicted by experience, and by the fact that there are now over 700 locomotives of this type in use, a number of them being run regularly at very high speeds.

The last two-cylinder type which we will illustrate, is given in figs. 21, 22, and 23, which show an engine built for the Jura-Berne-Lucerne Railroad, and which was shown at the Paris Exposition.

#### THREE-CYLINDER COMPOUND LOCOMOTIVES.

The first idea of a compound locomotive of the three-cylinder type made public was by my colleague, M. Jules Morandiere, in a letter published in *Engineering*, in 1866. In this, which described an engine proposed for the Metropolitan Railroad, in London, there were two groups, each having two axles coupled, the one worked by a single cylinder, the other by two. The first cylinder was the high-pressure cylinder, and the two others the low-pressure cylinders.

While studying, at Creusot, the engines built for the Bayonne-Biarritz Railroad, M. Andrade, then Engineer in the Navy and stationed at those works, proposed to use instead of two cylinders of different sizes, three cylinders, one in the center receiving the steam, the two others outside to be the low-pressure cylinders. These were to work on the same axle by cranks set at an angle of 120°. A starting valve similar to that of the Biarritz engines, but worked by a small steam cylinder, would permit the engine to be used either as a simple or a compound engine.

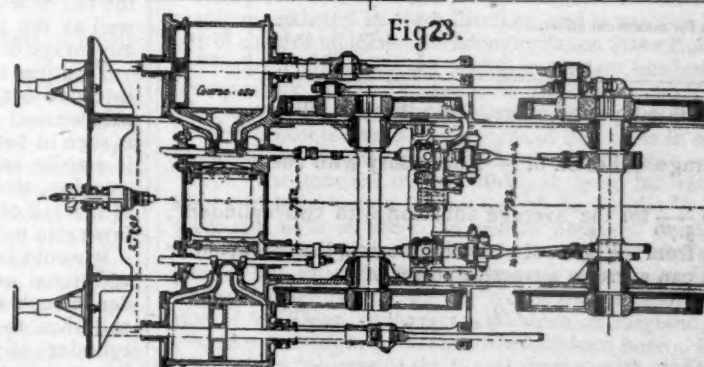
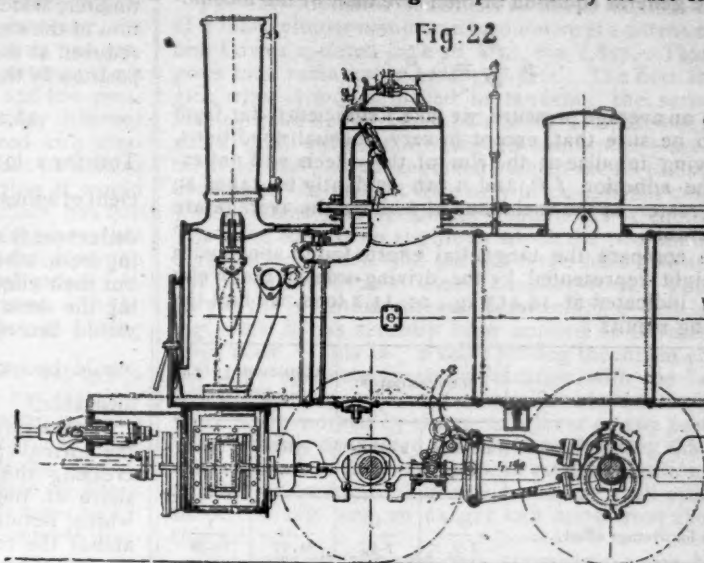
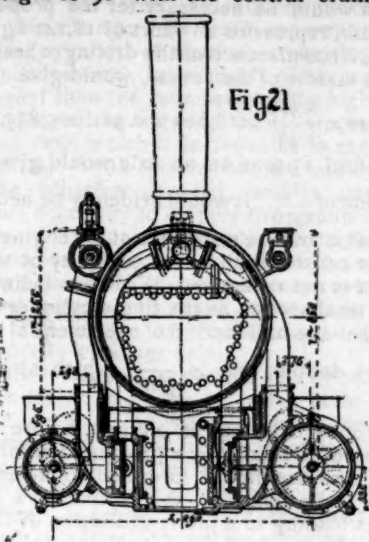
About the same time a Swiss engineer, John Moschell, proposed the use in locomotives of steam jackets and of a compound system with two cylinders. In reply to this I published an article supporting the two-cylinder type, or if the power of the machine should render that insufficient, a four-cylinder type, with the cylinders placed in tandem and working on the same crosshead. As I said at the time: "If the engines are not actually too heavily loaded at the start, we will be able at a very small expense to put them into condition to work much more economically, or even by using direct steam in the large cylinders to increase the power from 20 to 30 per cent., always on condition that the adhesive weight remains in proper proportion to the tractive effort. This would be easy to obtain in a number of engines where the axles do not carry more than from 9 to 10 tons."

This was a rational solution, and was adopted by the Northern Railroad of France, just 10 years later, on its eight-wheeled coupled locomotives.

The first three-cylinder compound engine which was put in actual operation was built in 1888, by Struwe, at Kolomna, in Russia. The three cylinders, the high-pressure in the center and the two low-pressure outside, worked on the same axle, the first by a central crank and the others by crank pins outside set in the same position, and at an angle of  $90^\circ$  with the central crank. This is the

than myself—to obtain good results from a type essentially defective, since it rests in part on an erroneous principle, the use of an axle worked by a single cylinder in a locomotive. The inherent defect of this type is not only in the fact that, if in starting, this cylinder happens to be at the dead point, it cannot assist in starting the train. There is another defect, perhaps much more serious, which has not been before indicated.

This is in the excessive variation in the moments of rotation around the driving-axle produced by the use of a single



same as Mr. Webb's first arrangement, for which, however, he can claim priority, as his design was made public in June, 1879, while the German patent taken out by Struwe for his engine is dated in October of the same year.

It is probable that the results from this engine were not favorable, since very little has been said about it.

At the end of 1881, Mr. F. W. Webb originated his celebrated type by building the engine *Experiment*—No. 34 on the table. Mr. Webb was convinced of the advantage of compound working, and wished to make an engine for high speed after the three-cylinder model of Stephenson, by causing the steam to work, in the first place, in the outside cylinders, and then in the central cylinder, the former working on crank-pins set in the same position, and at right angles with the central crank of the axle. This, he believed, would make an economical type, and one which would be very satisfactory at high speed. Mr. Webb hoped also to obtain a supplementary advantage by doing away with parallel rods, and making the high-pressure cylinders work upon one axle and the low-pressure upon another, the two axles being coupled only by the steam, if such an expression is allowable. To attain this object he was not afraid to use a single cylinder to run one axle.

This type, which has received some modifications in detail without changing its essential character, has been brought by its author to a high degree of perfection, and has been received with great favor by his admirers.

Nevertheless, it has required all the ability and perseverance of Mr. Webb—to which no one can do more justice

cylinder, in comparison with two cylinders having a total equivalent section and working on crank-pins placed at right angles.

Calculating these moments from the indicator diagrams obtained by Mr. Webb, and published by him, for running at full admission, say about 70 per cent. in the small cylinders, and for running at an admission of 35 per cent. in the same small cylinders—that is to say, at low speed and at high speed—first, for the axle worked by the large cylinder, and then for the same axle if it was worked by two cylinders of equivalent section acting upon crank-pins at right angles, we obtain the following results for the tangential strain at the circumference of the driving-wheels:

	FULL ADMISSION.		ADMISSION 35 PER CENT.	
	1 cylinder.	2 cylinders.	1 cylinder.	2 cylinders.
	kgs.	kgs.	kgs.	kgs.
Average tangential effort.	1.818	1.818	0.586	0.586
Maximum " "	3.437	2.500	1.330	0.833
Minimum " "	0.150	1.450	0.200	0.500
Difference.....	3.587	1.050	1.530	0.333
Ratio of maximum to average effort.....	1.89:1	1.38:1	2.27:1	1.49:1

If we compare the case of a single cylinder and that of two cylinders joined, we find the following:

	FULL ADMISSION.	ADMISSION, 35 PER CENT.
Ratio of maximum efforts.....	1.37	1.60
Ratio of differences.....	3.43	4.59
Ratio of maximum to average efforts....	1.37	1.60

In the general equation of the movement of the locomotive,

$$p \frac{d^2 l}{D} = P.$$

As  $p$  is an average pressure, we take  $f$  sufficiently far from unity to be sure that, except in very unusual conditions, the moving impulse at the rim of the wheels will not exceed the adhesion  $fP$ , and it can evidently be taken so much greater as the variations of  $p$  above the average are considerable.

If we compare the tangential efforts found above with the weight represented by the driving-axle of the Webb engine, indicated at 14,413 kg., or 14.2 tons, we find the following results :

	FULL ADMISSION.		ADMISSION, 35 PER CENT.	
	1 cylinder.	2 cylinders.	1 cylinder.	2 cylinders.
Adhesion for average effort.....	$\frac{1}{7.9}$	$\frac{1}{7.9}$	$\frac{1}{24.59}$	$\frac{1}{24.59}$
Adhesion for maximum effort.....	$\frac{1}{4.19}$	$\frac{1}{5.76}$	$\frac{1}{10.84}$	$\frac{1}{17.54}$

At full admission, then, the adhesion falls to  $\frac{1}{4.19}$  for an average adhesion of  $\frac{1}{7.9}$ , necessary with one cylinder, and to  $\frac{1}{5.76}$  for the average adhesion with two cylinders ; hence, from the point of view of adhesion, the two-cylinder engine can exercise a tractive power of

$$\frac{7.9}{5.76} = 1.375$$

in ratio to the single-cylinder ; this is a gain of about 40 per cent., or an improvement of 20 per cent. for the complete machine.

In stationary engines we overcome the variation of the moment of rotation by the use of fly-wheels of greater or less weight. In the locomotive, the driving-wheels act to a certain extent as fly-wheels, but in the Webb engine we have only a single pair of wheels, the rims and tires of which have not sufficient weight to regulate the force of rotation below a certain speed, which a very simple calculation shows to be, in round numbers, equal to 150 revolutions per minute, or a speed of 56 km. an hour. Below this speed the tangential effort will be periodically greater than the adhesion, and will lead to a slipping, which can only be prevented by making the large cylinder do a relatively small share of the work ; and this is what happens in the Webb engine.

It is hardly necessary to say that we cannot take into account the weight of the engine and that of the train to supplement the insufficiency of the fly-wheel formed by the driving-wheels, since the only relation which their mass has with the driving-wheels is through coupling. It is a case analogous to that of a stationary engine where the fly-wheels would be placed on a shaft worked from the crank-shaft by means of a belt or friction pulleys. It would be otherwise with the engine on a rack-rail road, where the advance would be produced without any possible slipping on the track.

This difficulty disappears when the speed is considerable. The machine is then essentially a fast running machine, but until it attains the number of revolutions indi-

cated above, it passes through a very unfavorable period. It is not so much the uncertainty in starting as the irregularity of the motion of the driving-wheels during the time necessary to obtain the maximum speed allowable.

The objection which we are striving to develop can be illustrated in a very simple way in the following manner : The locomotive *Dreadnought*, of the Webb type, has a large cylinder 0.762 m. in diameter, or 4.560 sq. m. in section. A pressure in the reservoir of 4 kg. per square centimeter, which would be necessary for the proper utilization of the steam, represents an effort of 18,240 kg., which, reduced at the circumference of the driving-wheels for the position in the middle of the course, would give

$$18,240 \times \frac{0.305}{0.95} = 18,240 \times 0.321 = 5,855.$$

This for a load of 15 tons on an axle would give a coefficient of adhesion of  $\frac{1}{2.56}$ . It would evidently be necessary to

deduct the friction and the resistance of the engine proceeding from other causes, such as the obliquity of the crank, but their effect is not excessive. With two cylinders having the same total section as the single cylinder the effect would decrease one-half and the coefficient of adhesion

would become double, that is,  $\frac{1}{5.12}$ , which is much more desirable.

With a single cylinder one is obliged, before attaining the normal speed, to reduce by a prolonged admission, decreasing the pressure in the intermediate reservoir, the share of the work done by this cylinder, a condition which, besides leading to a faulty utilization of the weight and of the machinery, leads to a very unequal division of the fall of temperature between the two groups, which, as well as the loss in pressure, causes us to lose part of the advantage of the compound working.

To utilize this difference Mr. Webb has, in some engines intended for special service, coupled a second axle to the axle worked by the high-pressure cylinders. The engine is then in better condition to start a heavy train, but there is hardly sufficient reason for preserving the compound working, since the unequal division between the cylinders of the fall of pressure and temperature is not a condition favorable to it.

It would be more rational in these engines to couple the additional axle to that worked by the low pressure cylinder in such a manner as to increase the regulating mass, and thus to permit us to utilize all the work which that cylinder can develop, if we could find a convenient arrangement for that purpose.

The Webb engine escapes with difficulty this dilemma, that it is not able to utilize the adhesion properly at low speed, and that at high speed the advantage hardly justifies the complication. It simply replaces the coupling-rods by a large cylinder and the complete mechanism attached, which is certainly a rather expensive way.

To return to the general arrangement of the machine, which should be well understood, I do not deny that the position of the cylinder in the longitudinal axis of the engine will secure excellent conditions of stability at high speed. This would be a most excellent idea if it did not involve inconveniences which more than balance its advantages.

Mr. Webb evidently knows well the weak point of his machine, and there is perhaps a sign of some modifications in his ideas in the patent taken out by him in 1888, the claims of which are the combination in the locomotive of two groups of cylinders in such a way that both can be worked by direct steam from the boiler or one by the steam from the boiler and the other by the exhaust steam from the first ; second, the use of the arrangements described in the patent to secure this object, and third, the coupling of the wheels worked by the different groups of cylinders.

It is hardly necessary to observe that this coupling would only be necessary if one of the groups is composed of a single cylinder. If there were two there would be no necessity for it. We will see further on some engines of this class which are entirely free from the criticism which has been made on the Webb engines.

Before quitting this subject a word must be said of the arrangement opposite to that of Mr. Webb, and that is the use of one high-pressure cylinder and two low-pressure ones, which has been presented by several persons, and which has been said to be a considerable improvement on the Webb engine. This assertion is based upon the greater ease of starting with the two large cylinders, on the smaller size of each of them, and on the possibility of having three cylinders of equal size and of working with direct steam in all three. We do not attach much importance to this change. Its most apparent advantage, the use of three cylinders of equal size requiring only one pattern of pistons, etc., loses much of its importance if we consider that then the ratio between the high and low-pressure cylinder will be only 1:2, unless we employ different strokes—a ratio which it is desirable to exceed with present pressures. With this method we would not be able to utilize the adhesion properly, and in starting it would always be necessary to employ the group which has two cylinders. This would require the use of the low-pressure cylinders in starting always with the direct steam from the boilers, which would involve a certain complication. In any case this movement would not at all do away with the inherent fault of the three-cylinder plan, that of having one cylinder to work one axle.

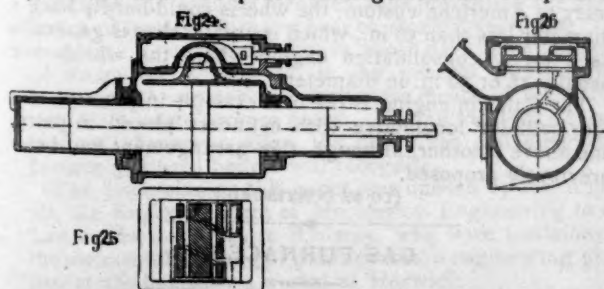
The only remedy is to double this cylinder, but then a three-cylinder engine—No. 37 in the table—has certainly been built on the plan indicated at the beginning of this chapter and worked out by M. Sauvage, Engineer of the Northern Railroad. This engine presents some very interesting details of which we have not space to speak further here. It seems, however, that this is rather an experiment than a type intended for adoption in current practice.

#### FOUR-CYLINDER COMPOUND ENGINES WITH TWO MOTIONS.

This first-class of four-cylinder compound engines was presented in my paper of 1877, as having four cylinders disposed in groups, each composed of a primary cylinder and an expanding cylinder placed tandem with a single valve motion for the pair. This system, with details well studied out, especially for the passage of the common piston-rod between the two cylinders, appears the most practicable for heavy locomotives, where the employ of a single low-pressure cylinder would require dimensions inadmissible in practice. This is probably the plan which has been most often proposed; it has the advantage of preserving the symmetry of the engine, and has against it only the appearance of complication, but this has been enough to prevent its use so far. It is probable that when we shall be more familiar with the principles of the compound working in the locomotive we will not be afraid to use four cylinders whenever necessary.

I cannot now modify essentially this statement, which I wrote 12 years ago.

The first trace which I have been able to find of the use of four cylinders applied to a compound locomotive is in a study made in 1860 by Mr. Ebenezer Kemp, which he has sent to me. This plan, which is shown in figs. 24, 25, and 26, has the title "Proposed Arrangement for Compound



Locomotive Engine," and is dated February 13, 1860. It represents an alteration intended to be applied to an engine on the Caledonian Railroad by substituting for each of the existing cylinders a group of two arranged as indicated above. This arrangement is very carefully studied out and the inconveniences arising from the use of interior stuffing-boxes is lessened by the fact that the parts which

they separate have not to undergo simultaneously extreme pressure. On the other hand, the plunger form for the high-pressure pistons allows us to give the waste space an importance which it should have in the corresponding cylinders in order to prevent exaggerated compression. The arrangement of the single valve is very ingenious, but we might criticise the space occupied by the plungers, which makes it necessary to increase the diameter of the cylinder and the surfaces in contact with steam.

The first published document in which mention is made of a four-cylinder compound locomotive is a patent of William Dawes's, dated June 20, 1872, No. 1,857. This patent gives four remarkable arrangements. The first is an engine with cylinders placed in tandem; the second is a four-cylinder engine, each pair being composed of a large and a small cylinder working on crank-pins placed at an angle of 180°, an arrangement which seems to have been used up to the present time only in exceptional cases, and which makes very satisfactory conditions of equilibrium. The third form is an engine in which the two small cylinders work one axle, and the two large ones another without the intervention or use of coupling-rods. The fourth part of the invention covers a detail which is very interesting, since it has recently been applied in Germany on a large scale. This is "a valve putting the steam-chests of the large cylinders in communication with the boiler at will for starting, working, or similar circumstances, this valve being worked by the reverse lever or any part of the valve motion connected with it in such a way that it will only open when this lever is in its extreme position, either forward or backward, and will be closed in all other positions. In this way no danger can arise from the use of this valve."

As I have already said, this arrangement has been recently reproduced by Herr Lindner, and is used on a number of compound locomotives on the Saxon State Railroads.

The form with cylinders placed in tandem has been later proposed by M. de Diesbach, by my colleague, M. Jules Garnier, and by others. As M. Polonceau proposed, I had in 1879 presented an arrangement of this class in order to facilitate the lateration of existing locomotives.

The first tandem engine built, at least for railroads, seems to have been a locomotive of the Boston & Albany Railroad, built in 1883, the results obtained from which showed only a very moderate economy, not sufficient to pay for the expense of maintenance. This was followed by the Nisbet engine, on the North British Railway, and that of Mr. Dean, of the Great Western, in England, which I have not thought necessary to reproduce here. It is not the same in the case of the Woolf engine, with eight wheels coupled, on the Northern Railroad of France, which was worked out by M. du Bousquet.\* I will not enlarge upon this type, which is perfectly rational in principle and which agrees with my own plans made in 1877. The only criticism to be made here relates to the increase in size of the large cylinders, the ratio of which with the small cylinders—1:3—seems to me excessive.

The advantage obtained by so great a prolongation of the expansion of the steam would be more than absorbed by the friction, and especially by the increase of surface offered for condensation by the cylinders and the pistons. I speak here of the surfaces in contact with steam, and I have had the curiosity to ascertain what this was for different compound locomotives so far built. This volume is that of the large cylinder multiplied by the ratio of the stroke and the diameter of the driving-wheels. The most rational term to which it has seemed possible to refer for comparison is the adhesive weight. On the other hand, it seems fair to reduce the value thus obtained to a uniform pressure, 140 lbs., for example, since we should wish to obtain an expansion as much longer as the pressure of the boiler is higher. We will thus calculate the value  $\frac{D^2 l}{DP}$ , and also that of  $\frac{d^2 l}{DP}$ , in these formulas  $d'$  being the diameter of the large cylinder, if there is only one, or the diameter of a fictitious cylinder equivalent to the sum of the sections of the large cylinders, if there are more than one.

\* This four-cylinder engine of M. du Bousquet was illustrated and described in the JOURNAL for March 1889, page 197.

We have thus obtained the coefficients given in the last columns of the large table. It will be seen that the Woolf engine of the Northern Railroad presents the ratio of 8.42, while this ratio is only occasionally over 6 in compound locomotives, and for the same pressure of 143 lbs. It descends as low as 2.96, but the most general value is between 4 and 5. It is true that with the increase to 170 lbs. pressure, the figure for the Woolf engine is reduced to 7, which is more reasonable, but still much higher than for most of the other engines. It is only just to say that the ratio of volume of the cylinders of 1:3 was probably not deliberately adopted, but was a consequence of the plan adopted for joining the pistons of the two cylinders by double rods, which requires a considerable relative difference between the diameters of the two cylinders. This method is simple enough, but I do not know to what point this quality of simplicity can compensate for the inconveniences proceeding from so great an increase in the volume, the weight, and the condensing surface of the large cylinders.

The Woolf system—that is, the direct passage of steam without any intermediate reservoir—requires a high ratio between the volumes of the cylinders, especially where the distribution is made by the single valve, but it is probable that a ratio of 1:2.50 would be sufficient, and, moreover, an arrangement with a reservoir could be adopted to still further diminish the diameter. The working of the Woolf system gives, it is true, a little higher maximum power in consequence of the almost complete elimination of the fall of pressure between the cylinders, but an equivalent advantage can be obtained by the reheating of the steam, which is effected by passing through the smoke-box the tubes forming the intermediate reservoir between the cylinders of each pair working compound.

This supposes a different method of connection between the pistons on the same side, which is not an insoluble problem. There are several solutions, among which is an original one given by me in 1879. This was for a passenger engine having the cylinders placed between the forward and the middle pair of driving-wheels. Figs. 16 and 17\* represent another plan made a little before for the lateration of a freight engine on the Northern Railroad of Spain. This change required only the lengthening of the frame and the addition of two small cylinders in front of the old ones, which were used as low-pressure cylinders. Fig. 18 shows, on a larger scale, the interior stuffing-box making the joint between the hollow rod *h* of the small piston and the solid rod *g* of the large piston, by the use of the tube *i* fixed in the partition separating the two cylinders.

The tandem arrangement applied to machines with six and eight wheels coupled has always the inconvenience of throwing too much weight on the front of the engine and, consequently, of requiring sometimes an additional load on the rear end—a doubtful solution—or the addition of a carrying axle in front which will not permit us to utilize all the weight for adhesion and will require an increase of the dead weight.

The Baldwin shops in Philadelphia have built for the Baltimore & Ohio Railroad a locomotive with four cylinders arranged in two groups working on the Woolf system, but the arrangement differs from the preceding one from the fact that the cylinders on each side, instead of being placed one before the other, are placed one above the other, as shown in figs. 30 and 31. The two piston rods are joined to a crosshead working in four guides, and with the pin for the connecting-rod in the center, as in the arrangement shown in figs. 19 and 20.\* The cylindrical valve, as shown in fig. 31, is worked directly by the link without the use of the rock-shaft common to American engines.

The locomotive in question has two coupled axles and a truck under the cylinders. The builders proposed to make an arrangement of double cylinders which could be applied easily and at small expense to the ordinary American engine.

The principal dimensions of this engine are as follows: High-pressure cylinders, 12 × 24 in.; low-pressure cylinders, 20 × 24 in.; ratio of volumes, 1:2.78; diameter of driving-wheels, 66 in.; grate surface, 24.11 sq. ft.; total heating surface, 1,604 sq. ft.; working pressure on boiler,

160 lbs.; weight on driving wheels, 75,400 lbs.; total weight, 105,300 lbs.

The following arrangements were adopted for the single valve corresponding to the two cylinders of each pair: Outside lap for the small cylinder,  $\frac{1}{4}$  in.; for the large cylinder,  $\frac{1}{8}$  in. Inside lap for the small cylinder,  $\frac{1}{8}$  in.; for the large cylinder,  $\frac{1}{4}$  in.

It was proposed in this engine to have the passages between the two cylinders as simple and direct as possible. This was reached, but with a very complicated casting; in fact, the two cylinders, the steam-chest, and one-half of the saddle were made in a single casting.\* The

Fig 31.

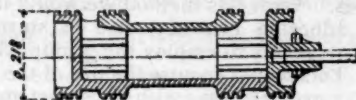
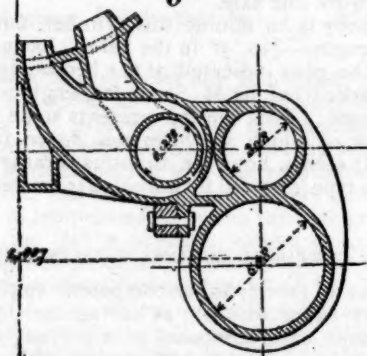


Fig 30.



arrangement adopted seems, besides, open to a serious objection for a very heavy engine.

The Woolf system permits us to obtain a maximum work a little higher than that of the reservoir system, but on the condition of accepting a certain difference between the work done by the two pistons. According to indicator diagrams taken of this engine the ratio of the work in starting is 1 for the small cylinder to 1.385 for the large one; but with the system of starting employed, which annuls the action of the small piston, the whole work can be, in starting, exerted by the large piston. This difference has no bad effect in the tandem arrangement, and it does not amount to much in the two-cylinder engine; it cannot be neglected when the pistons act on the extremities of a crosshead the center of which acts upon the connecting-rod. From this point of view this arrangement seems inferior to the tandem form, and would require more modifications in applying it to existing engines. The lowest point of the large cylinder is 22 in. below the common axis, and unless the cylinders are inclined, which is contrary to American custom, the wheels could hardly have a diameter less than 56 in., which is greater than is generally used for a consolidation engine where the wheels are usually 48 or 50 in. in diameter.

The Baldwin engine is the first example in practice of a four-cylinder locomotive with cylinders placed in pairs, one above another, although this arrangement had been previously proposed.

(TO BE CONTINUED.)

#### GAS FURNACES.

AT the recent meeting of the Institution of Mechanical Engineers in London, Mr. Bernard Dawson read a paper on this subject, a summary of which is given by *Nature*.

\* M. Mallet does not seem to be aware that casting the cylinder and half the saddle in a single piece is an arrangement very generally adopted in this country, and which has been found to work without serious objection. The addition to the casting made in the Baldwin compound engine is the cylindrical steam-chest, which in fact makes the casting consist of three cylinders instead of one; but this is not a serious objection for our founders.

\* See March number of the JOURNAL, page 110.

He began by stating that the greater number of gas furnaces in which crude heating gas has been successfully applied have been of the reversing regenerative type. There are many processes, however, requiring temperatures below that maintained by the use of regenerators, and in these gas furnaces have also been used with success. It is also often an advantage to be able to concentrate in one spot the manipulation of all the fuel required in scattered furnaces. For these reasons, among others, it is often desirable to employ gas fuel when the cost of saving in fuel may be a secondary consideration. The annealing of steel castings, heating plates and angle bars, etc., are cases in point. On the other hand, there are cases in which a higher temperature is required, such as cannot be attained by combustion of gas with cold air, and in these continuous regeneration—as opposed to reversing regeneration—may be applied; the regeneration having the effect of recovering the heat from the waste gases. In either case, the escaping gases must retain sufficient heat to secure the necessary draft; in fact, regeneration may be carried too far. The Author gives a useful word of warning on this point, some designers being of opinion that they cannot have too much of the good thing, regeneration. There have been many failures due to a want of appreciation of this point.

The Author divides gas furnaces into four classes: (a) With reversing regeneration; (b) with continuous regeneration; (c) non-regenerative; and (d) with blow-pipe, or forced blast.

Furnaces with reversing regeneration (Class a) are of several different kinds. (1) The ordinary Siemens furnace, the arrangement of which is well known. (2) The Batho or Hilton furnace, in which the regenerators are above ground. (3) Furnaces in which the air only is regenerated, the gas being admitted direct. (4) Furnaces in which a portion of the waste heat is taken back to the producer, as in the new Siemens furnace. (5) The regenerative blast-furnace stoves of the Cooper and Whitwell types.

In furnaces with continuous regeneration (Class b) the air is heated in flues by radiation or conduction from the bottom of the furnace, and through thin walls which separate the air-flues from the flues that carry the spent gases to the chimney.

In non-regenerative furnaces (Class c) the air is admitted to the furnace at atmospheric temperature.

The blow-pipe, or forced blast furnaces (Class d), are of two kinds: Firstly, those in which air is supplied at atmospheric temperature by a fan; and secondly, those in which the air is heated by the spent gases, by being passed either through coils or stacks of pipes, or else through brick tubes or flues.

For reasons already stated, we cannot follow the Author into the details of the various types here broadly sketched. The classification is, however, valuable, and supplies a standard which doubtless will be followed by others when dealing with this subject of daily growing importance.

In conclusion, he quoted the words of the late A. L. Holley, as follows: "Regenerative furnaces will gradually but inevitably take the place of the ordinary heating, puddling and melting furnaces, thus preventing the application of unspent furnace heat to steam generation." It should be remembered that in those days the generation of steam was looked on, in the general metallurgical trades, as the proper and legitimate means of recovering heat from waste furnace gases. How ill the device served this end those who know the difficulties and dangers of furnace gas fired boilers will recognize.

The discussion on this paper was opened by Mr. Aspinall, the Superintendent of Mechanical Engineering to the Lancashire & Yorkshire Railway, who bore testimony to the successful working of gas furnaces in engineering practice at the company's works, at Horwich.

Mr. John Head, who is connected with Mr. Frederick Siemens, also spoke at some length, in the course of his speech dealing with the new Siemens furnace, and giving instances of its successful working.

Mr. Smith-Casson also gave interesting particulars of a furnace he had designed and erected. This furnace has overhead regenerators, a type which is now attracting a

good deal of attention. It is interesting to note that Mr. Smith-Casson does not advocate overhead regeneration in all circumstances. It is a subject, he said, upon which he has still an open mind. As another speaker pointed out, there is this objection to an elevated regenerator, that the heated air naturally rises to the highest point, and therefore the circulation may not be as efficient as in cases where the regenerators are placed below the hearth.

Mr. A. Slater described a device in an ordinary boiler furnace in which iron retorts are placed at the back of the furnace bridge, and in these steam is dissociated and returns to the furnace for combustion of the gases. As Mr. Macfarlane Gray pointed out, this appears nearly akin to the perpetual motion theories; but a useful effect may be obtained by transferring heat from a place where it is not wanted to a place where it is. Mr. Slater said the application of this device gave a saving of 38 per cent. of fuel burnt, which only proves that Mr. Slater's boilers must have been of extremely bad proportions originally.

A good deal of the discussion turned on the burning of gaseous fuel in steam-boilers. Professor Alexander Kennedy said, as to the saving of burning gas with regenerative furnaces in metallurgical operations, there can be but little divergence of opinion; but in the case of generation of steam, quite a different set of conditions will arise. In steel-making, for instance, it is necessary that there should be intense local heat, and the gases must leave the furnace at an enormously high temperature. In boiler furnaces intense local heat is to be avoided, and the products of combustion pass to the chimney comparatively cool. Thus a steam-boiler may show an evaporative efficiency or fuel economy so high that little more heat is left in the spent gases than is necessary to supply chimney draft, and in such a case regenerators would be useless. In metallurgical operations the efficiency of the furnace would be something absurdly low without regenerators, perhaps not more than 5 per cent. These remarks he intended for those people who think that so much better results can be obtained by complicated gas-generating devices in steam-boilers than by burning coal simply and logically on a grate.

Mr. Dawson replied to his critics at considerable length, but without adding much to what had been already said in his paper.

## THE NORTH SEA-BALTIC SHIP CANAL.

(From *Mittheilungen aus dem Gebiete des Seewesens.*)

### I.—HISTORICAL.

WHILE the canals of the ancients served originally only to carry water for irrigation or city supply, it was at a very early period that their use for purposes of trade and for carrying vessels began.

Ptolemy and Pharaoh both worked to connect the Nile with the Red Sea. Under the Emperor Nero a survey was made and a plan prepared for cutting through the Isthmus of Corinth. Claudius Nero, a stepson of the Emperor Augustus, in the year 12 B.C., built the *Fossa Drusiana*, a canal which carried boats and which connected the Lower Rhine with the Zuyder Zee, near the present town of Doesborg.

In the eleventh century there were boat-bearing or commercial canals in Italy. The first canal of this kind in Germany was built in 1391-98, by Lübeck merchants between the Elbe and the Trave. This Delvenau-Strecknitz Canal was intended to connect the North Sea with the Baltic, and enable trading ships to avoid the stormy and dangerous passage around Cape Skagen. It was 35 miles long and 3 ft. deep.

In 1525 followed the building of the Alster Canal, which had also the object of connecting the Baltic with the North Sea. It extended from the Beste, a tributary of the Trave, to the Alster Lake, the outlet of which—the Alster, a river 32 miles long—discharged near Hamburg. Unfortunately this canal had only a short life, the warlike owners of the adjacent provinces having filled up the canal a few years after its completion.

On the rest of the canal there are no locks, so that ships will be able to pass through without delay. At Rendsburg a connection is made with the lower Eider by a lock through which vessels can pass, but this lock does not in any way affect the navigation of the canal itself.

On the straight sections and on curves of over 8,200 ft. (2,500 m.) radius, the width at bottom is 72 ft. On curves of less than 8,200 ft. radius, the width is increased in accordance with the following formula :

$$\text{Width} = 72' + \left( 85' - \frac{\text{Radius}}{180} \right)$$

Thus on a curve of 5,400 ft. radius, the width of the canal at bottom would be  $72' + 55' = 127$  ft. The depth everywhere at the average stage of water will be 29.5 ft.

The canal bed has a slope of 5 to 1, and the dikes, or protecting banks, of 2 to 1; in very soft ground the slope is 6 to 1. In the sections in high land the bank is protected by stone or rip-rapped for 6.5 ft. below low-water mark, and for 3.3 ft. above the average water-mark. In all the cuttings a berme 8.2 ft. wide is left, from the outer edge of which the slope, of  $1\frac{1}{2}$  to 1, begins. In low ground the berme bank is 16.4 ft. wide.

At the lowest stage of water the canal will have an available width of 118 ft. for ships drawing 19.7 ft. of water; in addition to this, and to provide for battle-ships of great beam, six passing-places are provided, in which the width is increased to 197 ft. at the bottom. Besides these the Obereider-see and the Andorfer-see serve as passing-places; the last-named lake can also be used as a turning place, giving room to turn around the largest ships.

The West Holstein Railroad will cross the canal on a high-level bridge, which will leave a clear opening of 138 ft. above the water. There will be three other railroad crossings where swing or drawbridges will be used, and three drawbridges for highway roads. For the less frequented roads 16 ferries will be provided, where passengers and teams will be carried across by ferry-boats.

The estimated amount of the earthwork required for the canal was about 100,000,000 cubic yards. The soil is chiefly sand with boulders, or sandy loam, or swampy. The sand excavated is used for the dikes, and also for strengthening the bottom in swampy land. Packed down it sinks into the bog, giving the bottom and slopes greater resisting power. The boulders taken out are valuable for rip-rapping, as stone is very scarce in the district through which the canal passes. While these boulders are apt to hinder considerably the work of the steam-shovels, it must be remembered, on the other hand, that on the entire line there is no rock-work, and no blasting will be necessary anywhere.

In the first two months of work—October and November, 1886—there were 162,500 cub. yds. excavated. Since then the plant and working force have been so increased that in June and July, 1890, there were 6,956,300 cub. yds. moved.

The plant in use on the work at the present time includes 27 steam-shovels, 26 dredges, 15 steam-tugs, 72 barges, 97 locomotives, and 2,700 dump cars.

The workmen employed are chiefly North Germans, with a small proportion of Bohemians and Italians. They are lodged in barracks erected for the purpose, which have been designed and built with strict regard to sanitary conditions and to secure the greatest possible amount of comfort.

The locks and bridges will be begun during the present year, and the entire work is to be completed in the year 1895.

It was at first intended to fill up the Flemhüder-see entirely, but this has been abandoned on the petition of the neighboring landowners, who feared serious injury to their tree plantations. There will be now a part left open forming a sort of circular canal; the upper part of the lake, to the line of the ship canal, will, however, be filled up.

### III.—COMMERCIAL VALUE OF THE CANAL.

The necessity for a canal before the time of railroads was so great that the old Eider Canal was built and used, in spite of its small depth of water, sharp curves, and numerous locks.

The railroads, however, altered this at a blow.

Canals are often closed on account of ice in winter, repairs, and sometimes lack of water. Their usefulness is limited by the nature of the ground and the supply of water, and the speed of ships passing through them must be limited on account of the washing of the banks.

The railroad can make much better time, and is better adapted to handle light freight. Moreover, branches can be run and stations placed conveniently for large manufacturing and other points where freight originates.

A boat of 2,000 tons displacement carries about as much as a heavy freight train. For heavy freight and articles of low cost, the water transport, however, presents great advantages.

To sum up the considerations in favor of the North Sea-Baltic Canal, it will probably not remain closed by ice in the winter, nor is there chance of a short supply of water. Apart from its military use it is of the first importance commercially, carrying large sea-going ships and very much shortening the distance between the two seas.

The disasters to ships taking the route around Cape Skagen have been carefully recorded from 1858 to 1885. During this time there ran ashore on the west coast of Jutland, near Cape Skagen, in the Cattegat, in the Great Belt, in the Sound, on the Islands of Falstenbo and Bornholm 6,316 ships, of which 3,133 were total losses. The greatest proportion of disasters was in the months of November, 19 per cent.; the smallest in June and July, 4 per cent. From 1877 to 1881 a total of 91 German ships, with 708 persons on board, were lost, which would have been preserved had the canal been opened. The money loss for Germany in this period is estimated at \$1,464,000.

The increasing safety for ships and cargo through the use of the North Sea-Baltic Canal is a great consideration, but it must be remembered that the entrance to the mouth of the Elbe and to the Brunsbüttel lock will not be easy in bad weather until some harbor works and lighting are completed. It should be noted also that the Danish and the Swedish Governments have done much in recent years to improve the lighting of the coast and the navigation around the Skagen.

The shortening of the voyage is a very important point for ports in the neighborhood of the eastern end of the canal. Ships for English ports starting from Lubeck will save 570 knots; sailing from Wismar 530, and from Rostock 570 knots. The shortening of the voyage between Bornholm and the Thames will be 200 knots, and this saving will increase for ships bound for ports in the north of England.

Through the canal a new business route will be opened that ought to bring much business to the province of Schleswig-Holstein. Recognizing this fact, Prussia has undertaken the payment of \$12,000,000 of the total amount of the cost of the canal, which was to be provided by the Empire.

As to the revenue to be expected from the canal, it is to be considered that the tariff charge for ships must be limited to an amount which will enable them to compete with the railroads for freight, and cannot, therefore, exceed a point which would enable the boats to carry at about three-fourths of the railroad rate. The sea route opened will, however, be of great advantage to some German industries. Coal and iron from the Rhine provinces, which heretofore have been able to compete with the English products only on the North Sea coast will, by the opening of this canal, in connection with the Dortmund Canal, be able to reach also the Baltic ports.

The building of the canal will make it necessary for the imperial authorities to improve the mouth of the Elbe and to put in additional lights there, in order to make navigation more secure for vessels seeking the entrance of the canal. It is intended to take measures for keeping navigation open and free during the winter season as well as for the rest of the year.

Official statistics show that in the five years 1877-82 in all 161,179 ships, having a registered tonnage of 53,000,000 tons, passed Cape Skagen, giving a yearly average of 32,235 ships and 10,600,000 registered tonnage. Of these, it is considered that ships from the north of England, Sweden, and Denmark will not use the canal, so that the proportion which would pass through would be about 18,000 ships of 5,600,000 tons. Adopting these figures, the estimated revenue from canal tolls will be about \$1,000,000, while the expense for the canal service, repairs, etc., would be about \$450,000, leaving a net revenue of \$550,000. The Imperial Commission which made these calculations does not con-

sider that the estimate was at all sanguine, since no allowance was made for the fact that by the time the canal is opened in 1895, the steamship trade to the Baltic will probably have doubled, and the estimate given above of the number of ships and tonnage will be a low one.

An incidental advantage of the building of the canal will be the draining of some of the swampy lands along the line, which will be made available for cultivation; and there will also be a gain of fertile land by filling in the Flemhüder-see. It may also be expected that Danish and Swedish vessels will in some cases use the canal in stormy seasons and in bad weather when the northern passage would be especially dangerous.

#### IV.—MILITARY VALUE OF THE CANAL.

Through the peculiar situation of its coast-line fronting on two seas, divided by the peninsula of Denmark, which would probably be neutral in any war, the German Empire is obliged to protect two coasts with its fleet. Although the German Navy has been largely increased during recent years, it is still outnumbered by those of England, France, and Russia. This is the more unfortunate for the Empire, since it must keep strong fleets in both the North Sea and the Baltic, and is thus compelled to divide its naval strength. To unite these two fleets in time of war would require a great deal of manœuvring, partly through narrow channels, which could easily be closed by guns, torpedoes, and submarine mines.

The North Sea-Baltic Canal will change all this. Situated entirely within German territory, in 24 hours a number of large ships can be passed through it. One end of the canal is in the harbor of Kiel, already strongly fortified; the other is in the mouth of the Elbe, which can be easily protected, so that from a military point of view the canal may be considered safe.

The German General Staff at first opposed any expenditure for the canal. Later, however, its views altered, when an increase of the naval force was decided on, and it is mainly due to the influence of the General Staff that the building of the canal was decided on in 1886.

The advantage of the canal for the navy is seen when we consider that a naval power seeking to attack Germany in either sea can quickly be confronted by the entire fleet. In other words, the fleet can be moved on an inside line and its entire force thrown against an enemy advancing on either sea, thus practically doubling its force.

It is also to be considered that the ships now planned and under construction will almost double the present strength of the navy by the time the canal will be completed, in 1895, making Germany a strong naval power.

#### THE PRESERVATION OF IRON AND STEEL STRUCTURAL WORK.

BY WOODRUFF JONES, A.M.

ONE of the most important economic questions of the present day is the preservation of iron and steel structures. In this country many millions of dollars are annually spent in the erection and construction of these, and the amount is increasing in rapid proportion. Bridges, buildings, viaducts, ships, and machinery are now being made of these materials to almost the entire exclusion of others. From their very nature iron and steel are peculiarly subject to decay from atmospheric and other influences. The question of preserving them is not merely one of dollars and cents but, especially in the case of railroads, one affecting the lives and property of a large portion of the community. What, then, is the best method of preserving them?

The almost universal method is by means of paints, or the application of substances to their surface which will resist or retard the influence of air, water, and other destructive agencies. The requisites of a good paint for this purpose are that it shall adhere firmly to the surface and not chip or peel off, thereby leaving portions of the surface exposed. It must not corrode the iron, else the remedy may only aggravate the disease. It must form a surface hard enough to resist influences which would remove it by friction, yet elastic enough to conform to the expansion

and contraction of the metal by heat and cold. It must be impervious to and unaffected, as far as possible, by moisture, atmospheric and other influences to which the structure may be exposed.

The paints that have been used for this purpose are principally asphalt and coal-tar paints, consisting of mineral and artificial asphalt or coal tar either applied alone or combined with each other and, more or less, with metallic bases, and iron oxide paints and lead oxide paints, especially red lead, in all of which the pigment is held to the surface of the iron or steel by combination with linseed oil.

The choice of paints must lie, so far as our present practical experience goes, between these three classes, zinc oxide being found to be entirely unsuitable on account of a propensity to peel off. What, then, is found to be the experience in actual practise with these?

Asphalt and coal-tar paints run when exposed to the sun and other sources of heat, which is a serious matter with vertical surfaces, and after a time become extremely brittle and scale off entirely, leaving the under surface exposed unless the paint is constantly renewed. In the mean time the exposed iron and steel are being corroded by rust.

Iron oxide paints, including "metallic brown," are paints made from iron ore, or by some chemical process with an iron base. These are invariably iron in a greater or less degree of oxidation, or, in other words, rusted iron. Now it is well known that one of the most active promoters of rust or decay in iron is the rust itself. Under the combined influences of the moisture and carbonic acid of the atmosphere iron oxide, or iron rust, becomes a carrier of oxygen from the air to the metal, rust begetting rust. It is therefore evident that this material alone has no preserving effect on iron; in fact, it promotes its decay.

How is it when combined with linseed oil in the form of paint? In the economy of nature iron oxide is a great disinfectant. When in contact with organic matter and moisture, even at a low temperature, under favorable conditions it readily gives up oxygen, destroying, more or less, the organic matter and being itself reduced to a lower oxide. When thus reduced, with equal readiness it absorbs oxygen from the atmosphere and again passes it on, thereby promoting and eventually insuring the destruction or transformation of the organic matter with which it may be in contact either in the soil or elsewhere. The same process appears to take place when combined with linseed oil in the form of paint and exposed to atmospheric influences, the oil being the organic matter.

If linseed oil, in drying, formed an air and water-proof film, it might be urged that the oxide of iron would be entirely protected from the direct influences of oxygen of the air and moisture; such, however, is not the case. The most eminent authorities have recently shown that the dried film of linseed oil, unless united with a pigment that combines chemically and forms a waterproof coating with it, actually absorbs water very much like a sponge. Where water will go, air will also go, and we thus have in direct contact with the iron oxide of the paint, which does not combine chemically with oil, those elements—air, moisture, and organic matter—which cause the iron to become a carrier of oxygen and a destroyer of what it is in contact with.

It is well known that iron paint darkens with age; this is caused largely by the iron oxide losing oxygen, which is partly transferred to the oil, burning it up and destroying its tenacity, as may be seen by examining iron structures painted for some time with iron paint or metallic brown, the paint being found extremely brittle and in feathery scales.

This is not all the damage that is done. The iron oxide in the paint becomes a carrier of oxygen to the very metal it was designed to protect, and the process of corrosion is commenced and carried on under the paint, which eventually peels or scales off, the surface of the metal being found more or less oxidized and corroded.

Asphalt and iron oxide being thus shown to be entirely incapable of preserving the iron, it remains for us to consider the effect of red lead. This pigment has the property of forming with linseed oil a hard elastic coating clinging with great tenacity to the metal. It has no ox-

dizing effect on iron and does not act as a carrier of oxygen from the atmosphere after the paint has set, neither does it render the oil brittle nor promote rust.

When red lead fails it is principally by gradual wear or friction from the outside. It does not scale or blister, which both asphalt and iron oxide paints will do, thereby requiring a thorough scraping and removal of old material before a new coat can be applied. Any red lead pigment adhering to the metal forms a permanent base for subsequent paintings and is utilized in further preserving the metal.

The Government specifications for iron work in the new Library Building of Congress provide that "all the work not Bower-Barffed must be given one coat of pure red lead paint—not metallic paint of any kind, but *pure red lead*—before leaving the shop and before becoming rusted."

The experiments of the Navy Department on the preservation and fouling of plates covered with different pigments may be interesting. A plate of iron covered with asphalt paint was immersed in sea water for eight months and six days at the United States Navy Yard, Portsmouth, N. H. At the end of that period it was found to be covered with scum and mud and very badly rusted. A plate coated with iron paint immersed at Key West, Fla., was found to be covered with branch shell and coral, but little paint remaining, and very badly pitted and rusted. A plate with two coats of red lead, at the Norfolk Navy Yard, was found to have a few barnacles attached, but to be in fair condition, with no rust whatever on the iron after the paint was removed. It will be seen that not only did the red lead protect the iron better than the other pigments referred to, but that the plates were in far better condition as regards barnacles and fouling. The superiority of red lead being thus established, it is adopted for use on hulls of Government war-ships.

On the Dutch State Railroads a series of experiments extending over a period of three years were made with the above pigments on scrubbed plates, as well as those which had been pickled in acid to remove the scale. It was found that the red lead was superior in each case to the others.

If red lead is thus proven to be the best pigment for preserving iron and steel structures, what is the proper method of applying it? We have seen above that the value of red lead depends upon its forming a hard, elastic coating having a great tenacity for the iron. This is owing to its forming certain combinations with the oil and actually setting very much the same as plaster of Paris or cement sets when mixed with water.

To successfully work with the latter substances it is necessary to put them in shape as quickly as possible after mixing with water before the setting takes place. If the chemical action of setting has partly taken place the material may be moulded, but it is well known that good results will not be obtained. Red lead, like these substances, must be applied to the work before it sets with the oil. It is on this point that failures in the use of the pigment have generally occurred, because if it be applied after the combining or setting process has taken place, the hard, elastic, clinging coating will not be formed on the iron surface.

The following is the practise of one of our largest ship-building establishments in applying red lead to the hulls of Government vessels: The plates are first pickled in a dilute solution of muriatic acid, then passed through rapidly revolving wire brushes, which remove all scale and dirt, leaving the iron with a bright, smooth surface; then thoroughly washed with pure water and rubbed entirely dry and immediately coated with red lead and pure raw linseed oil. The red lead is first thoroughly mixed with just enough linseed oil to form a very thick, tough paste, which will keep for several days without hardening. This paste as wanted for use is thinned down to the proper consistency for spreading with pure linseed oil, and applied at once, care being taken to leave paint-pots empty at night. A gallon of paint thus prepared contains about 5 lbs. of oil and 18 lbs. of red lead, and will cover on first coat about 500 sq. ft., the second coat about 600 sq. ft.

In this way the red lead and oil get their initial set on the surface of the iron, and the closer the pigment is brought to the iron the more durable will it be found.

Some parties prime iron with iron oxide paint or metallic brown before applying red lead, which I believe to be a mistake, as this paint readily scales from iron and, of course, carries the lead with it. Others coat the iron with oil before applying the red lead; this, too, prevents the adhering paint from coming in contact directly with the surface, and should be avoided, provided the iron is properly prepared, by thorough cleaning and removal of any scale and moisture, which is a matter of the greatest importance. In priming wood surfaces which are absorbent of oil, the best practise favors the putting on of a coat of pure oil, or oil thinned with turpentine, which shall penetrate the surface and form a binder for the subsequent coats. With iron the case is quite different, provided we have a paint which, from its very nature, can attach itself firmly to the surface, because it is out of the question for it to hold on to the surface of iron by any process of absorption into the pores of the metal, as linseed oil will not penetrate to any extent. Such a paint should be put directly on the surface of the clean, dry metal—as is done in the cases of Government vessels referred to—without the intervention of a coat of oil or other substances.

The rusting of iron before the application of paint, which is sometimes recommended, should by all means be avoided, as it not only prevents the contact of the paint with the metal, but induces a chemical action which may go on with its corroding work under the applied paint.

As to the relative cost of iron oxide paints and red lead, there is no doubt that the first cost of painting structures with iron oxide is somewhat less than with red lead. The best railroad authorities state, however, that labor in painting structural work costs twice as much as material. The true economy must, therefore, be sought in the durability of the paint as well as the preservation of the structure from rust. Actual experiments have shown that structures painted with iron paint had to be repainted the third or fourth year, those with red lead not until the sixth year. In the second painting with iron paint the old material must be entirely removed before a fresh coat can be properly applied, entailing considerable increased cost, whereas with the red lead no such expense is necessary, but, as before stated, a portion of the pigment remains on the iron, continuing to protect the surface, and is the very best base for the new coat, besides contributing materially toward it, thereby lessening the expense of each repainting.

It will therefore be easily seen that, although in first cost of red lead may be slightly dearer than the iron paint, yet in the long run it will be greatly cheaper, besides giving assurance, for the reasons above stated, that the structure is not deteriorating from the effects of the atmosphere and paint.

Before closing this article it might be well to allude to the effect of lamp-black when mixed in small quantities, say an ounce to the pound of red lead. It changes the color to a deep chocolate, a possible advantage in some cases, and also prevents the red lead from taking its initial set with linseed oil as quickly as when mixed with oil alone. Experiments recently made showed that this compound would remain mixed in paste form with linseed oil some 30 days without hardening. Thorough mixture is of the greatest importance and should be done in the dry state before adding the oil. If rapid drying is desired, Japan dryer can be mixed with the oil used in thinning the paste before application with the brush.

Too much stress cannot be laid on the great importance of having the metallic surface perfectly clean and as free as possible from scale and rust before the application of the paint. Where pickling with acid is impracticable, as is frequently the case in railroad and other structural work, thorough brushing with wire brushes should be resorted to.

#### MECHANICAL TREATMENT OF MOULDING SAND.

In a paper recently read before the English Institute of Mechanical Engineers, Mr. Walter Bagshaw remarked that if a waster casting be made it is invariably and not unnaturally attributed to accident, when it may be more probably due to want of skill; for even moulders them-

selves are not generally credited with a scientific knowledge of the principles on which their art depends. In large shops there is, of course, a competent foreman, who is responsible for the execution of orders in the most economical way; whereas in smaller foundries, even important work, such as the preparation of cores and the mixture of sand, is not infrequently carried out by unskilled workmen in a rather empiric manner. On the subject there seems to be as much difference of opinion as there is diversity in practice. Some moulders place faith only in kneading or treading the few simple materials composing their facing sand, jealously guarding the preparation as a trade secret, and condemning all machine work; while others are equally emphatic in favor of the particular machine for grinding, riddling or combing, to which they have been accustomed.

He described a view, magnified 500 diameters, of sand found and much used in the West Riding of Yorkshire. He said, "In its natural state it will be noticed that a portion of the grains adhere together in clusters, varying in size from masses containing hundreds of sand grains to smaller groups of three or four grains, most of them small enough to pass through an ordinary fine riddle without disintegration. The form and size of the groups are very irregular, and many are covered with a fine scaly powder. Samples from the bulk show a preponderance of grain groups devoid of uniformity. There are exactly the same appearances in fine Mansfield and other sands, though the presence of sharp crystals may be more frequent, and the abraded corners not so conspicuous." Referring to another view he said, "This represents new sand mixed with coal dust and burnt sand. The black spots dotted over the new grains are particles of coal which attach themselves in this manner, and when subjected to the heat of molten metal are converted into coke, often enveloping the sand grain with a crust. In none of the specimens examined was coal found in a separate loose state. Other views illustrated samples of old sand very much like gas coke, with perhaps more of a metallic luster, and the extent to which sand may be destroyed by burning or chemical action." Numbers of these friable hollow husks occur in a more or less broken condition, and are easily reduced to fine powder by concussion with other particles. If used again in sufficient quantity, they will cake and cause metal to boil. One diagram illustrated the formation of a shell round a sand grain, a shell which could be cracked like a nut, exposing a kernel of clean sand. Coal dust, as commonly found, takes the form of angular splinters with laminated surfaces. When magnified 500 diameters it appears only like a fine powder; the larger pieces are not present in quantities if the coal has been properly ground. These materials, after incorporation, are generally coated with some other substance, plumbago being the most preferred; but it is difficult to give a correct impression of this article in a drawing. When viewed in bulk it is fluffy, like soot; and the outlines of separate flakes are not well defined by the prevailing light and shade. The chemical composition of sand will obviously affect the nature of the casting, no matter what treatment it undergoes. Stated generally, good sand is composed of 94 parts silica, 5 parts alumina, and traces of magnesia and oxide of iron. Sand containing much of the metallic oxides, especially lime, is to be avoided. Geographical position is the chief factor governing the selection of sand; and whether weak or strong, its deficiencies are made up for by the skill of the moulder. For this reason the same sand is often used for both heavy and light castings, the proportion of coal varying according to the nature of the casting. A common mixture of facing sand consists of 6 parts by weight of old sand, 4 of new sand, and 1 of coal dust. Floor sand requires only half the above proportions of new sand and coal dust to renew it. German foundries adopt one part by measure of new sand to two of old sand, to which is added coal dust in the proportion of one-tenth of the bulk for large castings, and one-twentieth for small castings. A few foundries mix street sweepings with the coal, in order to get porosity when the metal in the mould is likely to be a long time before setting. Plumbago is effective in preventing destruction of the sand; but owing to its refractory nature it must not be dusted on in such

quantities as to close the pores and prevent free exit of the gases. Powdered French chalk, soapstone, and other substances are sometimes used for facing the mould; but next to plumbago, oak charcoal takes the best place, notwithstanding its liability to float occasionally and give a rough casting. The author then described mixing by hand riddling and treading, power riddling, roller mill, centrifugal mixer, toughness of sand, working expenses, and the durability of centrifugal mixer.

## THE UNITED STATES NAVY.

### THE PRACTISE SHIP.

THIS ship is under construction by S. L. Moore & Sons, at Elizabeth, N. J. The accompanying illustration, from the report of the Bureau of Construction and Repair, shows a side view and deck plan.

Peculiar difficulties attended the designing of this ship, which is intended to have, as far as possible, all the main features of a modern war-ship on a very limited displacement, and to be supplied with all the varied appliances necessary to give the naval cadets full training in the management of the latest type of vessels.

The vessel is a twin-screw steel cruiser, with the chief dimensions as follows: Length between perpendiculars, 180 ft.; extreme breadth, 32 ft.; mean draft, 11 ft. 6 in.; displacement, 835 tons.

Unlike some of the other cruisers, she is provided with considerable sail power. The rig is that of barkentine, the sail area being about 5,000 sq. ft.

The armament consists of four 4-in. rapid-fire rifles protected by steel shields; two 6-pounder, two 3-pounder, and one 1-pounder rapid-fire cannon; one 37-mm. revolving cannon, one Gatling gun, and two torpedo-tubes, one above water, and one bow launching tube.

There will be a full electric plant, steam steering gear and other appliances. Quarters are provided for captain, eight officers and 120 cadets and seamen.

The engines, one for each screw, are of the direct-acting, vertical, inverted, triple-expansion type, with cylinders 13½ in., 21 in., and 31 in. in diameter and 20 in. stroke. There are two boilers, each 8 ft. 8 in. in diameter and 17 ft. long, with two corrugated furnaces 39 in. in diameter.

The coal capacity is 140 tons on normal draft. With this supply the radius of action is 1,560 knots at 13 knots an hour; 2,400 knots at 10 knots an hour, or 3,850 knots at 8 knots an hour.

### THE NEW BATTLE-SHIPS.

A sketch of one of the new battle-ships has already been given in these columns, but the accompanying engraving, from the report of the Bureau of Construction and Repair, shows the design more completely, giving an elevation and two half-deck plans. The condensed description below gives the dimensions as finally settled. Two of these ships, the *Massachusetts* and the *Indiana*, are under construction at the Cramp yards, in Philadelphia; the third—the *Oregon*—at the Union Iron Works, in San Francisco.

The general dimensions are as follows: Length on water-line, 348 ft.; extreme breadth, 69 ft. 3 in.; draft, 24 ft.; displacement, 10,200 tons.

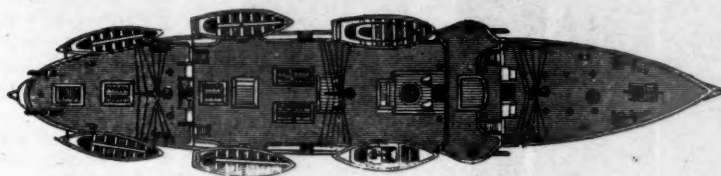
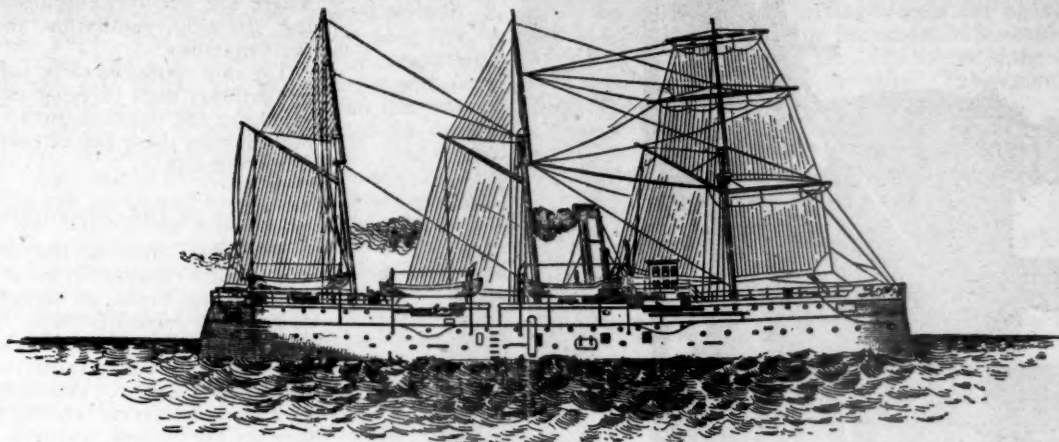
There is a belt of 18-in. armor extending 3 ft. above and 4 ft. 6 in. below the water-line. Rising from this at each end are armored redoubts of 17 in. in thickness, extending above the main deck 3 ft. 6 in., giving an armored free-board of 15 ft. 2 in. These redoubts protect the turning gear of the turrets and all the operations of loading. The turrets are inclined, 17 in. thick, powerfully strengthened. The side-armor belt is backed by 6 in. of wood, two 4-in. plates, and a 10-ft. belt of coal. The vessel above the belt has 5 in. of armor protection.

The 8-in. guns have barbettes of 10 in., inclined turrets of 8½ in., and cone bases and loading-tubes of 3 in. The 6-in. guns are protected by 5 in. of armor, and have 2-in. splinter bulkheads worked around the deck. The 6-pounders between decks have 2-in. armor worked around them; elsewhere the usual service shields. The 1-pounders are protected by 2 in. of steel. The deck over the belt is 2½

in., and at the ends 3 in.; this is made up of two thicknesses of  $\frac{1}{2}$ -in. mild steel plates with the remaining thickness in one plate. There is a 10-in. conning-tower, the connections being through a tube protected by 7 in. of steel.

the 13-in. guns, having a train of  $14^\circ$  across the middle line. Special attention has been paid to ease and protection of the ammunition supply.

A full electric plant, with search-lights, is provided for ;

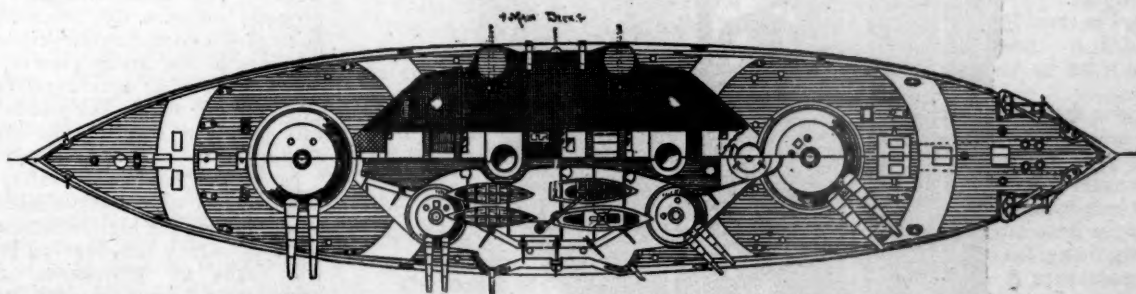
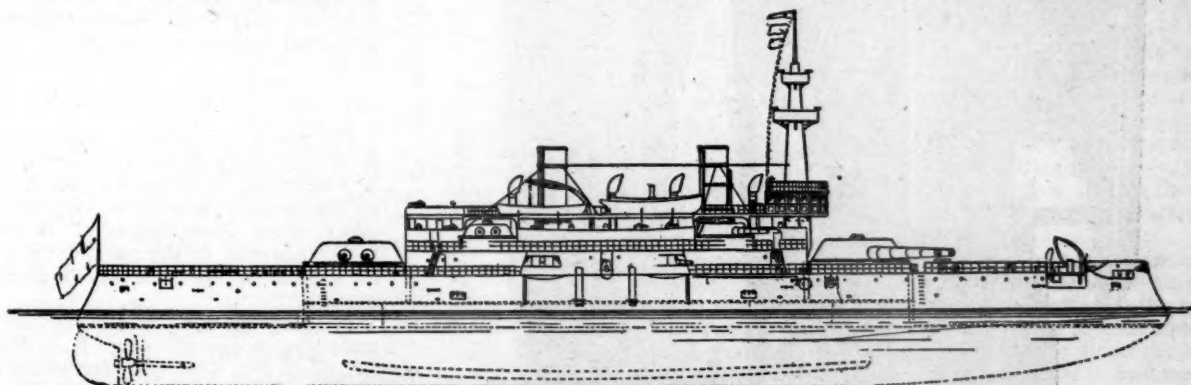


PRACTISE CRUISER FOR THE UNITED STATES NAVY.

The main battery includes four 13-in., 35 caliber, breech-loading rifles; eight 8-in. breech-loading rifles, and four 6-in. breech-loading rifles. The secondary battery consists of twenty 6-pounder and six 1-pounder rapid-fire guns, two Gatling guns, and six torpedo tubes.

also torpedo-nets and all the latest appliances. Special strengthening has been given to the sides and deck, to enable them to withstand the great strains caused by the firing of the larger guns.

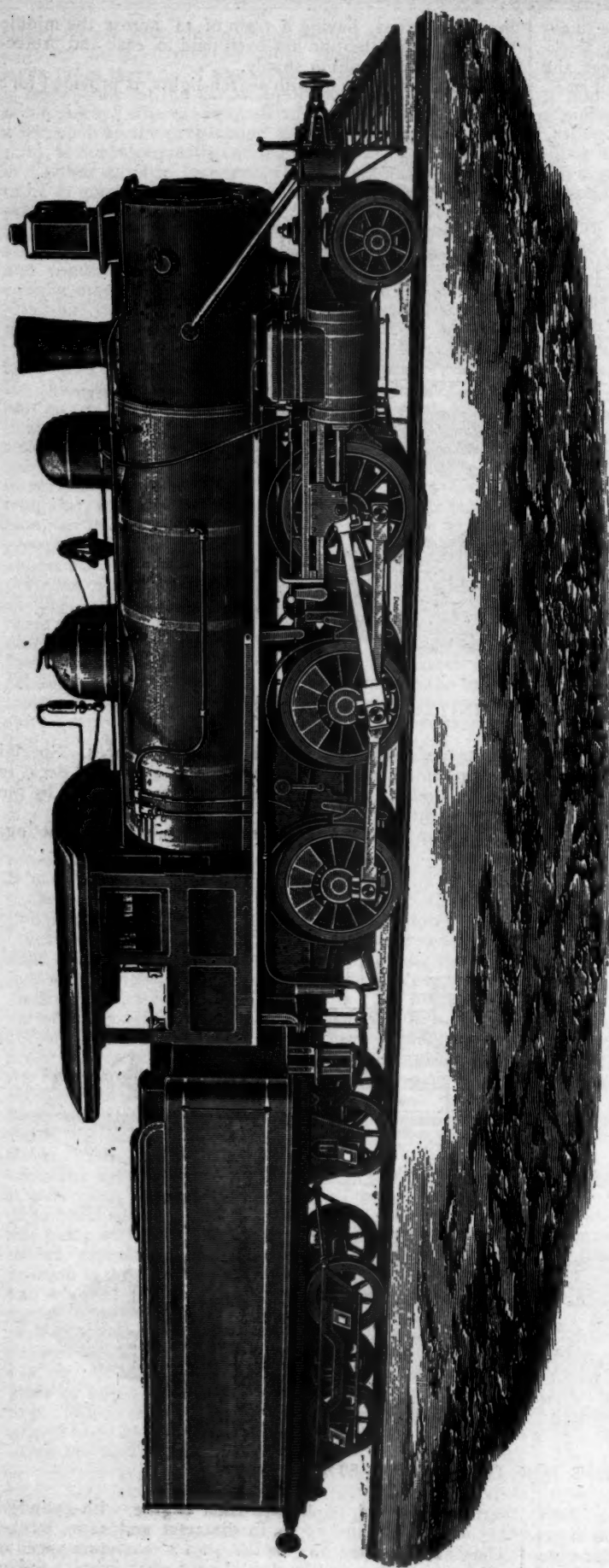
The ship has twin-screws, each driven by a direct-acting,



THE NEW BATTLE SHIPS FOR THE UNITED STATES NAVY.

The 13-in. guns are 17 ft. 8 in. above water and have great arcs of fire; the 6-in. guns are 14 ft. 10 in. above water, and all fire across the center-line. The 8-in. guns are 24 ft. 9 in. above water, and can fire over the tops of

vertical, inverted, triple-expansion engine, with cylinders 34 $\frac{1}{2}$  in., 48 in., and 75 in. in diameter and 42 in. stroke. They are expected to give the ship a maximum speed of 16 $\frac{1}{2}$  knots, and a sustained sea speed of 15 knots. Steam



MOGUL LOCOMOTIVE FOR JAPANESE GOVERNMENT RAILROADS.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

is furnished by two single-ended boilers, each 10 ft. 2 in. in diameter and 8 ft. 6 in. long; and by four double-ended boilers, each 15 ft. in diameter and 18 ft. long. The working pressure will be 160 lbs. There are auxiliary engines for pumping, draining, ventilation, and running the dynamos.

The ship carries no sails, and has only one military mast carrying two tops for rapid-fire and machine guns. The ammunition for these can be carried up inside the masts.

#### TRIAL OF THE "BENNINGTON."

The official trial of the *Bennington* was made February 28, by a trip from New London, Conn., on the Atlantic and down Long Island Sound. On a four hours' run, with high wind and heavy sea, making about 65 knots, the average speed was about 16.5 knots, the highest 17.2 knots an hour. The highest pressure on the boilers was 170 lbs., the greatest speed of the engines 159 revolutions per minute. Under the conditions of the trial the engines developed about 3,314 H.P., or 86 H.P. below the contract requirements. The ship, it is stated, acted very well, and was easily managed, even in a pretty heavy sea.

The *Bennington* is a duplicate of the *Concord*, which was described and illustrated in the JOURNAL for April, 1890, page 168. She is an unarmored gunboat 226 ft. long, 36 ft. beam, 14 ft. mean draft, and 1,703 tons displacement. She will carry six 5-in. rifled guns, five small rapid-fire guns and eight torpedo-tubes. The twin-screws are driven by two vertical triple-expansion engines, each having cylinders 22 in., 31 in., and 50 in. in diameter, and 30 in. stroke. The ship will have a full electric light plant and other modern appliances.

#### THE NEW PROVING-GROUND.

The new naval proving-ground, which is to take the place of the present one at Annapolis, is at Indian Head, Md., on the eastern bank of the Potomac, 26 miles below Washington. It is much better adapted to the purpose than the old ground, where there was never room enough.

The new grounds have been fitted up under the charge of Ensign R. B. Dashiell, U. S. N., who was detailed for the work. The tract occupied by the grounds includes 659 acres of land, so as to give a considerable reservation on all sides of the firing ground, in order that in case of an accident flying pieces of metal will not be likely to fall on private property, resulting in claims for damages.

From the landing a valley several hundred feet wide extends inland, while on either side the high hills form natural butts on which the heaviest projectiles will make no impression. A ravine branching off some distance up the valley forms a sheltered location for the powder magazine and storehouses. When work was commenced the valley was a marsh, but the stream flowing through it has now been confined to a single channel and a system of drain-

age has been established by which all surface water is carried off.

There will be three firing positions or batteries. The first and most important of these is the velocity battery, which is now nearly completed. It is placed several hundred feet up the valley from the landing on the right-hand side, and will for the present contain mounts for 6-in., 8-in. and 10-in. guns. The projectiles will be fired directly across the valley into a sand butt made by excavating a tunnel into the side of the hill and filling it with sand. This is 500 ft. from the battery, and between the two are two velocity screens 100 ft. apart connected by electric wires with the chronograph house, situated over the hill behind the gun platforms and several hundred yards away, where the jar caused by firing the heavy guns will not affect the delicate instruments by which the time of the projectile's flight between the two screens is measured. An excellent bomb-proof, capable of affording protection to a large number of men, has been found by tunneling into the hill-side near the gun platforms. It will also be a convenient place for storing heavy projectiles near the guns.

The range battery is to be placed on the opposite side of the valley near the river, in a position where it will command a clear range directly down the river, and long enough to range any gun that will be built for the navy. Work on this battery is advancing rapidly. A third battery will be placed near the wharf, almost at the water's edge, in a recess cut into the hill-side. This will be used for testing experimental guns where there is danger of bursting, and the high banks will prevent flying fragments from doing any damage.

The most interesting feature of the proving-ground is the system of handling and moving heavy guns or other material. A specially designed scow has been built, carrying an ordinary standard gauge railway track and a special car on its top. This car can be run off on the railway at the Washington Navy-Yard and can be loaded in any of the shops. In the same manner it can be run off the barge at Indian Head upon a track running back quite a distance from shore.

A traversing car, carrying a traveling crane, is then run over the car, and the weight to be moved is lifted by the crane. The traversing car is then run upon a turntable, by means of which it can be shifted to any track desired and carried to any part of the ground where it is wanted. The gun platforms are elevated so as to be exactly level with the top of the traversing car, so that the crane can be run off of the car and directly over the carriage on which the gun is to be placed. The crane is capable of lifting 75 tons. It has just been completed at the Washington ordnance shops. The hoisting gear is carried overhead, supported by a strong framework of steel, resting on the track wheels. The gear has a transverse motion, as well as vertical, so that the load can be deposited at any point within the 13 ft. covered by the crane.

#### A JAPANESE MOGUL LOCOMOTIVE.

THE accompanying illustration shows a locomotive built by the Baldwin Locomotive Works, in Philadelphia, for the Japanese Government Railroads. The engine is of 3 ft. 6 in. gauge, and is one of several in use on a road having very heavy grades and sharp curves. One of these engines was recently tested specially on the section of 15 miles between Gotembu and Numadzu, where there is a total rise of 1,500 ft.—an average of 100 ft. to the mile, the grades varying from 88 ft. to 132 ft. to the mile. The performance is stated to have been very satisfactory, though no particulars are given.

The engine, as will be seen from the engraving, is of the mogul type, with six drivers and a two wheel truck, outside cylinders and extended smoke-box. The boiler is of steel, the barrel being 57 in. in diameter. The fire-box is of steel, 7 ft. 5½ in. long, 2 ft. 5½ in. wide, 4 ft. 8 in. deep in front, and 3 ft. 11 in. at back. There are 201 tubes, 10 ft. 9 in. long and 2 in. in diameter. The heating-surface is: Fire-box, 109 sq. ft.; tubes, 1,122 sq. ft.; total, 1,231 sq. ft. The usual working-pressure is 140 lbs.

The cylinders are 18 in. in diameter and 22 in stroke. The steam-ports are 16 × 1½ in., and the exhaust-ports 16 × 2½ in. The valve motion is of the usual shifting link type.

The driving-wheels are 48 in. in diameter. The fixed wheel-base of the engine is 12 ft., and the total wheel-base 19 ft. 8 in. The driving-wheels are spaced 6 ft. apart, and the distance from the center of forward drivers to center of truck is 7 ft. 8 in. The center of the boiler is 6 ft. 6 in. above the level of the rails. The engine is fitted with driver-brakes. Its total weight is 40 tons.

The tender is carried on one pair of 33-in. wheels in fixed bearings forward, and a four-wheeled truck under the rear end. The tank has a capacity of 2,600 gallons.

#### THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

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(Continued from page 126.)

#### IX.—TESTING.

THE efficiency of a system of mines depends upon a thorough testing of all the material and means employed in its construction and operation. This testing begins in the workshop and is continued unremittingly so long as the mines are in service. The never-ceasing motion of the sea, storms, wear and tear of material, loosening of joints, and the varying pressure upon the case, are some of the causes in constant operation to impair the efficiency of a submarine mine.

Before the mines are planted all the material to be used is subjected to careful mechanical or electrical tests, or both. The mine-cases, for strength and water-tightness by submergence and hydraulic pressure; the cables, for tensile strength and the insulation and conductivity of their wires; the fuses and disconnectors, for resistance and efficiency; the anchor-ropes, for tensile strength; the anchors, for holding power, and the junction-boxes and all mechanical joints, for water-tightness. While the mines are being put down, all joints and connections between electric wires are tested as they are made. The batteries are tested for electro-motive force and general efficiency. After the mines are down and the final connections made, the electrical tests are the only ones then available, yet with proper instruments, it is possible at any time to determine the condition of the whole system or of any particular mine.

The above refers particularly to a system of electrically controlled mines. With a system of purely self-acting mines all the mechanical tests would be applied to the material. To thoroughly test the efficiency of a mine of this character, whether explosion is produced by direct contact or by a falling weight, it would be necessary to fit it up in all respects as for service, except the exploding charge, to properly moor it, and then subject it to all sorts of collisions with a vessel at different rates of speed. A subsequent examination would determine whether or not it had behaved in a satisfactory manner.

All the cables of a system of electrical mines are led through an underground gallery to the testing-room at some secure point on shore. In a permanent work this would usually be in an underground casemate. Here are gathered all the instruments for testing and sometimes the batteries for firing the mines. The wire from each mine is led to a separate binding screw on the test-table and given a number corresponding with its mine. A separate galvanometer for each mine is desirable. The testing battery should be in addition to the one used for firing.

The cables are usually submerged in tanks before they are put down, and tested for resistance and conductivity. The fuses are tested for efficiency by connecting them up in a circuit, which includes a resistance coil representing

the entire resistance of the circuit as arranged for actual service, and exploding them. This test will also indicate the safe limit of strength of current for use in ordinary testing. To test the efficiency of the disconnecter or cut-off-fuse, a circuit is made up which includes a mine and disconnecter-fuse arranged as in service, and a resistance representing the other parts of the mine circuit, and then fired with a strength of current sufficient to fuse the platinum wire bridges, and then testing to see if the broken end of the wire is properly insulated.

The condition of a mine as regards moisture is a difficult thing to ascertain. Resort may be had to what is known as the *sea-cell* test which, although delicate, is about the only one possible. In this arrangement advantage is taken of the fact that if two suitable plates of metal, as zinc and copper, or zinc and carbon, are immersed in salt water, a current is generated capable of deflecting the needle of a galvanometer, which deflection varies in direction and in degree with the metals used. The simplest form of a "sea-cell" is to place in circuit within the mine-case, between the circuit-closer and the shore, a zinc plate, and beyond the fuse to form the ordinary earth-connection is a plate of carbon. At the shore station is a sensitive galvanometer from which connection is made with a submerged copper plate. By connecting up to the galvanometer, carbon and zinc plates, as well as copper, another set of combinations would be obtained, giving different indications on the instrument. Under normal conditions, when the mine is dry, a sea-cell is formed between the carbon plate and the copper of the home station, and a deflection is given to the needle of the galvanometer in a certain direction. Should, however, the mine-case leak and the zinc plate within come in contact with sea water, a cell is formed between the zinc and copper pair, and a different deflection is given to the needle. Should the cable become injured and its copper wire exposed to the sea, a cell of two copper plates will be formed and the fact indicated by the galvanometer.

To determine whether a buoyant contact mine maintains its position the telephonic test may be had. For this purpose there is a telephone at the shore station and one within the mine, properly connected. Upon the diaphragm of the latter a number of small loose shot are placed. The uniformity with which the mine sways under the action of tide or current will give a good indication as to the condition of its moorings. Should the shot come to a rest, it can safely be concluded that the mine has met with some mishap and is upon the bottom.

#### X.—FIRING.

Almost any kind of an electrical current may be used for firing submarine mines. The objections to a high-tension current, such as is generated by a frictional or dynamo-electrical machine, have been mentioned in connection with fuses. An open-circuit battery generating a current of low-potential, like the Ladauché, is much to be preferred. Such a battery possesses the advantages of being easily cared for, economical, and always ready for use, and is now generally employed for both testing and firing purposes.

The manner of firing electro-contact mines has already been explained. The contact of a vessel with the mine is, by means of a circuit-closer, made to ring a bell or drop a shutter, leaving it to the judgment of the observer whether or not to switch in the firing-battery and fire the mine. To render the mine automatic, the signalling current, instead of giving the usual signal, is made to bring in the firing battery at once. This may be done in various ways, as, for instance, by making this current act upon an electromagnet which, drawing down a pronged lever into two cups of mercury properly connected with the firing-battery, brings this battery automatically into circuit.

When the mines are connected up in groups, the explosion of one of the group may be made to break the circuit for that group for a few seconds, until the tumult caused by the explosion shall have subsided, reducing thereby the danger of sympathetic explosion.

To serve as a permanent indication to the operator at the firing-station that a mine has been exploded and is out of action, it is customary to introduce into each circuit at

that station an *igniter*, a contrivance much like an ordinary fuse which, exploding with a mine, serves the purpose indicated.

At night, or as an extra precaution during fogs, guns bearing upon the mine-field may be loaded, trained, and so connected up with the firing-battery that the explosion of a mine will automatically draw their fire upon that part of the field.

*By observation.*—In an observation, or judgment mine, no indication of its proximity to the mine is given by the vessel itself. Its position must in some way be determined from the shore station. The first controllable mines were put down by the Confederates in the James and some of the Western rivers. The channels being narrow, a single mine was all that was required, and the only preparation necessary was a firing-pit on one bank, and a stake or some marked point on the other and in line with the mine. A vessel in the channel and upon this line was within the destructive area of the mine. When, however, the mines are numerous and distributed over a considerable area, two observing stations are necessary, and the position of the hostile ship must be determined by simultaneous observations taken from both with plane-tables, theodolites, or other angle-measurers. The position of the mines may be known by the bearings of stakes or distant objects, but the better way, and the one now usually employed, is by the use at each station of a permanent graduated arc upon which is indicated the bearing of each mine or group of mines. This arrangement gives to an enemy no indication of the position of the mines. The stations should be so situated that the lines passing from them over each mine shall form as nearly as possible a right angle.

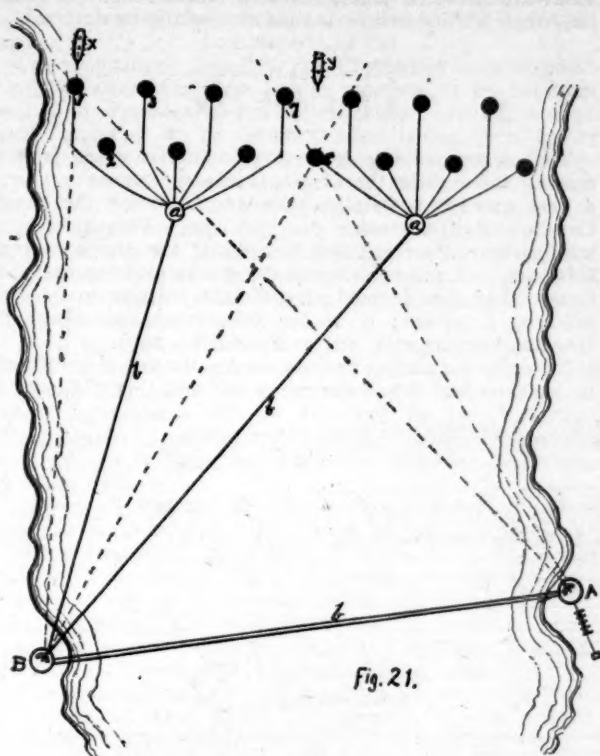
The two stations having been selected overlooking the mine-field the mines are buoyed, and from both stations the bearing of each mine is carefully taken and recorded. This might be the compass-bearing, but the use of the permanent graduated arc is to be preferred. This firing arc, as used in the English service, is a cast-iron skeleton frame including 77° of a circle of 34-ft. radius. Above this arc a telescope, with cross-wires, is mounted upon a vertical axis, which is the pivot of the circle. Below the telescope, and rigidly attached to this pivot, is an arm extending to the outer rim of the instrument, and carrying a contact-making point at its extremity. The arc having been properly set up and levelled, the bearing of each mine is carefully taken, and a contact-point numbered to correspond with its mine is securely clamped to the outer rim. In tracking a vessel, when the telescope swings upon the line of a mine, the arm striking against its contact-point indicates the fact to the observer, who can then put down the corresponding key upon the switch-board. By insulating these contact-points, and properly connecting them up with the firing-battery, the latter may be brought into circuit without the intervention of the operator, although this is not the usual method.

Judgment mines may be fired either by single or double observation, but the former can be employed only for a very limited number connected up to one line and fired simultaneously, marking buoys indicating to the observer the position of the mines. In double-observation firing there are two or more stations, depending upon the number of lines of mines, each station having an observer and an instrument. The station at which the batteries and testing instruments are located is known as the firing-station.

Fig. 21 shows a double line of electro-contact mines in groups of seven. *A* is the firing, *B* an observing station. The arrangement of the electrical wires is as follows: Starting at the fuse in the mine-case one terminal is put to ground through the anchoring gear, the other passes to the junction-box *a* through the disconnecter-fuse to the multiple cable *b*, thence to station *B*. Here the wires are separated, pass over the key-board, and then, in one or two multiple cables, to station *A*, where the wires are again separated, passing over the key-board at the firing-station to the firing-battery and to ground.

As thus connected up there will be, under ordinary circumstances, two breaks in each electrical circuit—at the key-boards of the stations *A* and *B*—which must be closed before the mine can be fired. Suppose a vessel to be

approaching the mine-field, as upon the line  $B$  1. The observer at  $B$ , the instant it passes upon that line, puts down his key, closing the break at his station and leaving only that at  $A$ . Should the vessel hold its course, the observer at  $A$ , when it arrives upon the line  $A$  1, or over mine No.



1, puts down his key, the circuit is closed and the mine fired. If approaching, as at  $y$ , both keys would go down simultaneously when the vessel arrived over mine No. 8.

With such an arrangement as above indicated, there would always be the possibility that the observers at the two stations might be following different vessels when more than one was approaching the mine-field, and so failure to explode the mines result. This difficulty can be obviated by an arrangement by which the observer at  $B$  can cause a signal corresponding to each individual mine to operate at the firing-station so long as a vessel remains upon its line, leaving the final act of firing the mines with the observer at that station. Electrical communication must, of course, be maintained between the two stations.

When the mines are upon a single line, as shown in fig. 22, the firing arrangements are very simple. At the firing-station  $A$  are the electrical batteries and a firing arc arranged, as in the case just described, with seven contact-points to indicate the line of mines.  $B$  is simply an observing-station. The observer here is provided with a telescope mounted in much the same way as has been described, but without the graduated arc. This is set to mark the line of mines. Upon the approach of a hostile vessel a warning signal is set in operation at the firing station, which is changed to the danger signal so long as it remains within the destructive reach of the mines. The observations taken at  $A$  determine when and what mines are to be fired.

The objection to a single-line arrangement of mines is that the destruction of a single mine opens a gate to the harbor; also, the discovery of the presence of one would indicate to an enemy the approximate position of the whole system, knowledge that would be of the greatest value were countermining operations to be undertaken. It might be said, however, that the necessity for depending upon a single line of mines is likely to be rare. In this connection it may be mentioned that a plan for running out a line of single mines in any desired direction has been proposed. This plan contemplates securing the mines to a large hawser, the end of which is carried out in the

desired direction and rove through a heavily anchored block, and the hawser then drawn taut on the bottom. Whether this scheme is a practicable one may be questioned.

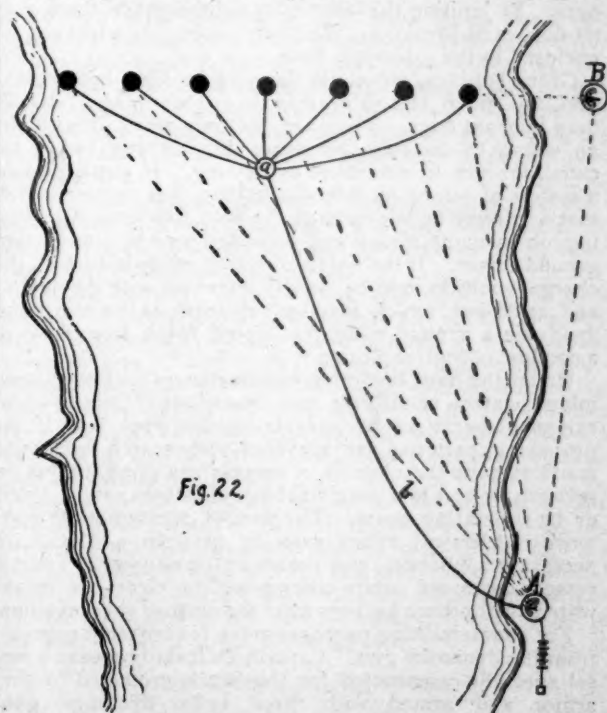
Both the firing and observing-stations must not only have a clear view of the mine-field, but must also be in situations rendered secure against attacks by landing parties from a hostile fleet, as well as from the fire of machine and rapid-fire guns. Security may usually be attained by placing the stations at some distance from the shore and concealing their location from the enemy, supplementing these precautions, when necessary, with means of protection and defense. That neither station should be in close proximity to a fort or battery is evident. The use of smokeless powder for heavy guns has, as yet, scarcely reached the experimental stage, and under present conditions the station observers of a mine system would be seriously handicapped by the smoke, noise, and confusion prevailing in the neighborhood of a battery in action.

*Skirmishing Mines.*—To confuse an enemy as to the position of the permanent mines, as well as to give warning of the approach of small boats at night or in foggy weather, as for countermining, it is proposed to scatter irregularly in front of the ground occupied by the regular system numbers of small electro-contact mines. These would ordinarily be arranged to fire automatically, although not necessarily so.

#### XI.—COUNTERMINING.

To neutralize or destroy the mines of an enemy resort is had to countermining. Various means are resorted to to accomplish this object. In the case of electrically controlled mines, the most effective way of putting a group or system out of action is to rupture the multiple cable leading to the firing-station. Next to this the destruction or neutralization of the individual mines is to be sought. This is accomplished by cutting its electrical cable, or destroying the mine by attaching to it a small electrical mine and exploding it.

A fleet setting out to open a passage in the mine-field defending a harbor would provide boats for creeping, for



sweeping, and launches for countermining. Row-boats would be sent over the field to creep for the cables with properly constructed creepers or grapnels. If not too deeply submerged or too heavy they may be raised and cut; otherwise destroyed by explosive grapnels. Boats in pairs, with drag-ropes or nets between them, would sweep the field for the mines themselves. The counter-

mining launches following would endeavor to attach their countermines and complete the destruction.

It seems more than probable that the electric light will play an important part in this connection in the future. As long ago as 1887 some experiments were made at the naval torpedo station with submerged incandescent electrical lamps. These lamps were from 100 to 150 candle-power, secured to the end of torpedo spars and submerged to varying depths up to about 20 feet. The light was sufficient to render objects within a radius of 100 to 150 feet distinctly visible, and there was little or no glare above the water to betray the presence of a boat.

The use of an electrical light by submarine divers would seem a better method of using this kind of subaqueous illumination. A diver's helmet devised by Lieutenant Scotti, of the Italian Navy, for the purpose of examining the bottoms of ships could very well be used for the purposes of submarine countermining. The lamp used is a 100-candle-power Bernstein. The light is projected in a cone through the thick glass front by a reflector in rear. The current could be supplied by accumulators upon the accompanying launch. Experiments with this lamp indicate that a diver can make his way with ease either over rocky or muddy bottom seeing objects with great distinct-

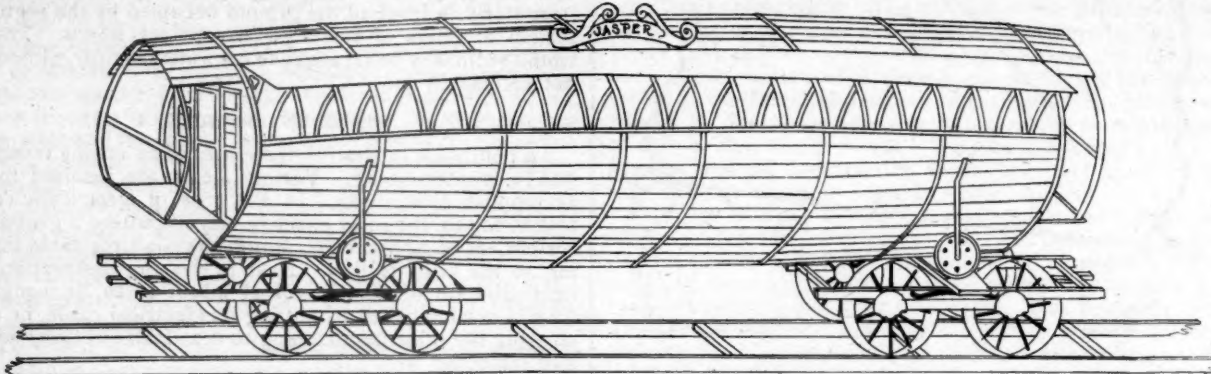
the dynamite gun—from 1 to 2 miles—the presumed presence of shore batteries armed with long-range, high-power rifles, and the very moderate thickness of armor such a vessel would be likely to carry, would seem to indicate that such a craft would be blown out of water long before it came within effective range of its air-guns. If the guns can be maintained within effective distance of the mine-field their ability to open a road can hardly be doubted.

(TO BE CONTINUED.)

#### A CURIOUS CAR.

THE accompanying engraving, which is made from a tracing taken from the original drawing, shows a car of a very curious pattern, which was built for the South Carolina Railroad some 50 years ago. The drawing is still preserved among the records at the shops of that Company. An inscription on the drawing shows that this form of car was deemed of sufficient promise to be covered by a patent; it reads: "Patented by George S. Hacker, January 21st, 1841. Patent No. 1937."

No scale is attached to the drawing, so that it is difficult to say just how large the car was; and this difficulty is



CAR BUILT FOR SOUTH CAROLINA RAILROAD IN 1841.

ness. By igniting the lamp after submergence there was no danger of breaking. The two conducting wires can be enclosed in the air-supply hose.

Ground mines, especially those to be fired by observation, are much less vulnerable to countermining attacks than buoyant ones. They are not only more difficult for an enemy to discover, but more difficult, even when located, for him to neutralize or destroy. In putting down a system of mines to defend a harbor, it is recommended that a fairway be left through the field free from all floating or buoyant mines and defended only by observation ground mines. If the depth of water exceeds 40 feet the charge would have to be rapidly increased with the depth; and at 80 feet, which may be put down as the maximum depth for a ground mine, this would reach from 1,500 to 2,000 lbs. of high-explosive.

Under the most favorable circumstances an attack upon mined waters is difficult and hazardous. Only at night can such operations be undertaken, and even then if the protecting batteries are provided with search-lights and machine guns the chances of success are small, unless resort can be had to a purely submarine attack, as by divers or by submarine boats. The danger of attempting to remove mechanical mines, even by daylight, and with all necessary appliances, was shown by the number of Federal vessels destroyed while attempting to clear the mined waters of Southern harbors after the close of the Rebellion.

For countermining purposes much is at present expected from the dynamite gun. Captain Zalinski proposes a vessel specially constructed for this work, protected by 5-in. armor and armed with three 15-in. dynamite guns mounted forward, as in the *Vesuvius*; these to carry 8-in. sub-caliber projectiles containing 100 lbs. of high-explosive. A round of three shell will clear, it is supposed, a width of 100 ft. at a discharge. To countermine a channel 7 miles long and 100 yards wide it is estimated that 1,200 shell will be sufficient. The short range of

increased by the evident fact that the draftsman was not skilled in perspective. If we take the end door as a standard, it would make the car about 45 ft. long, and the wheels 51 in. in diameter, which seems hardly probable; it is much more likely that the door and platform are incorrectly drawn.

The size, however, whatever it was, does not affect the general design. The car-body may be roughly described as a barrel laid on its side, and composed of wooden staves bound with iron. A long opening in the side serves in place of windows, and the end platforms shown in the drawing were probably continued through the car as a floor, although there is nothing to indicate it.

An inscription on the drawing indicates that the car was to be used either for passengers or freight. In the latter case the side opening might be closed, or dispensed with altogether.

The car was carried on two trucks with wooden frames and outside bearings. No center pin is shown on either truck, but it seems as if there must have been one. There are side-bearings very similar to the old Winans roller-bearing, and the springs are under the cross-brace in the center of the truck. The axle-boxes are apparently attached rigidly to the frame. The wheels are of the spoke pattern.

It will be noticed that the draft was from the trucks, no draw-bar of any kind being shown on the car-body.

It would be interesting to know how long this car was in service, what finally became of it, and whether more than one was built.

#### THE CELEBRATION OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM.

THE Committee in charge of the patent celebration to be held in Washington on April 8, 9, and 10 announces that, in view of the limited seating capacity of the largest public hall in Washington, it has been found necessary

that admission to the public meetings, at which addresses will be delivered by distinguished speakers, will be by ticket only. This rule will also hold for the public reception to be given at the Patent Office and for the excursion to Mount Vernon. Persons desiring to attend the meetings and participate in the reception and excursion should make application at once to J. Elfreth Watkins, Secretary of the Executive Committee, 811 G Street N. W., Washington, D. C.

The programme issued by the Committee is as follows: April 8, afternoon, first public meeting, to be presided over by the President of the United States; evening, second public meeting, to be presided over by the Secretary of the Interior; evening, 9 P.M., special reception to inventors and manufacturers at the Patent Office by the Secretary of the Interior and the Commissioner of Patents.

April 9, afternoon, third public meeting, presided over by Hon. Frederick Fraley, of the American Philosophical Society and the Franklin Institute; evening, fourth public meeting, to be presided over by S. P. Langley, Secretary of the Smithsonian Institution.

April 10, special anniversary day, being the anniversary of the signing of the first American patent law. In the morning there will be an excursion to Mount Vernon, where an address will be delivered by Dr. Toner, of Washington. In the evening the fifth public meeting will be held, to be presided over by Professor Alexander Graham Bell.

Among the distinguished gentlemen who have promised to make addresses at the different public meetings are: Edward Atkinson; Dr. John S. Billings, U. S. A.; Judge Samuel Blatchford; Mr. O. Chanute, President of the American Society of Civil Engineers; Senator J. W. Daniel; Professor Thomas Gray; Mr. A. R. Spofford, Librarian of Congress; Professor R. H. Thurston; Professor William E. Trowbridge, and a number of others.

The general and local committees have expended a great deal of labor on the arrangements for the celebration, and it is expected that they will be very complete.

On the afternoon of April 7 a meeting will be held to organize the National Association of Inventors & Manufacturers, and other meetings will be held later as opportunity is afforded. A number of prominent gentlemen have agreed to join in this proposed Association, and addresses from some of them may be expected at the meetings.

### OUR NAVY IN TIME OF PEACE.

BY LIEUTENANT HENRY H. BARROLL, U. S. N.

(Continued from page 117.)

THOSE naval duties heretofore considered have been of a nature which may be classed as entirely military; and although pursued in time of peace, are yet such as render it a more perfect defense to the nation in time of war. When the nation is at peace, however, the Navy can and does in various ways further the maritime interests of the country.

It is the duty of all civilized nations that each shall take its part in the policing of the sea. A hundred years ago the ocean was swarming with pirates where now thousands of vessels are peacefully sailing in the pursuit of commerce; and these seas would again be terrorized by pirates were it not for the navies of the world. True, the age of steam has made it impracticable for these gentlemen of the sea to continue their depredations so boldly as in former times, but long before steam vessels came into general use the pirate's doom had been practically sealed; while if the several nations should now withdraw their cruising ships, pirates would soon reappear, and could easily supply themselves with coal from captured steamers.

In time of peace the presence of one of our vessels in a foreign port, instead of being regarded as a menace, serves to intensify the friendly relations already existing between the two powers. The recent visit of the White Squadron to the newly established Republic of Brazil created a good impression, and that nation lost no time in sending a squadron to our waters, thanking the President for the courtesy shown.

Our foreign squadrons, instead of making these special visits, are at all times exhibiting our flag in foreign waters, extending to all quarters of the globe a knowledge of our manufactures, and strengthening the friendships already existing between the United States and other powers.

The most distinguished instance of the good effect of this branch of naval occupation is the expedition made to Japan, in 1853, by Captain M. C. Perry, U. S. N., and which resulted in giving to the civilized world the companionship of a people who are now recognized to be one of the most intelligent, refined and progressive of existing nations. In 1882 Commodore Shufeldt, U. S. N., in like manner formed a treaty with the hitherto exclusive Korean nation, which, with its 8,000,000 inhabitants, has now opened its harbors to vessels bearing American manufactures, the sales of which are each year rapidly increasing.

During peace a vessel cruising on a foreign station is not likely to interfere in the execution of that nation's laws, yet there are times when the mere presence of an American vessel in a foreign port will avert the oppression or maltreatment of one of our citizens there engaged in business.

### SURVEYING AND DEEP-SEA SOUNDING.

To the Navy properly belongs the province of surveying or mapping out the different great oceans and their shorelines. In this work all civilized nations have assisted, each generally surveying, in addition to its own shores and waters, a portion of those under semi-civilized or less enterprising governments.

Considering that our nation has had but little more than one hundred years of existence, we have thus far fully performed our share of this duty; and to-day the United States is cited by other nationalities as possessing the most complete and efficient system for collecting and distributing hydrographic information.

Owing to the establishment of the U. S. Coast Survey as one of the sub-departments of the Treasury, instead of the Navy Department, naval surveys cease when we reach our own shores; although the hydrography here is still mainly executed by officers and seamen temporarily transferred from the Navy to the Treasury Department for that purpose.

Foreign surveys executed by United States naval vessels have mainly been made along the coasts of Mexico, Central and South America, China, Japan, Corea, the Pacific Islands, and the coasts of Africa, etc., while for our knowledge of the more advanced European countries, we depend upon surveys made by themselves—engraving plates from the charts which these other countries have published.

All of the principal nations of Europe have been prominent in the charting of the earth's surface; and there are now few parts of the globe which are not covered by comparatively well-constructed charts.

Among nations, Great Britain has done the largest amount of hydrographic surveying; and to this is partly due the superiority of her ocean commerce over that of other nations. The British Hydrographic Office now publishes about 3,000 different charts and 100 books of sailing directions, covering all quarters of the globe, showing the best routes and channel-ways that exist across the seas and into all known harbors, and clearly marking the various dangers to navigation.

In the earlier days of our nation the people of the United States, in order to navigate even our own coasts, were dependent upon charts printed in England, and the plates of which were always retained there. In recent years, however, the United States has made great strides in this work, and now stands a close rival to England in the amount of aid given to navigation.

### THE HYDROGRAPHIC OFFICE.

In 1830 there was founded a depot for the collection and preservation of charts, chronometers and other nautical instruments belonging to the Navy, and for the collection and distribution of maritime information. This depot was the foundation of the present Hydrographic Office and of the Naval Observatory. Lieutenant L. M. Goldsborough, U. S. N., was appointed as first Superintendent

of the "Depot," as it was then designated, and it has ever since been under the direction of the Navy Department.

The hydrographic and astronomical duties of the Depot became of such diverse natures that their combination under one management was no longer practicable. In 1866 a division was made, since which time the two institutions have had separate superintendents. Both institutions are under the direction of the Bureau of Navigation.

The United States Hydrographic Office now publishes about 1,300 charts of foreign coasts and harbors and over 100 different volumes of sailing directions, besides annually distributing, for the benefit of navigators, tons of printed information.

These items of information thus distributed vary greatly in character. In addition to the production of charts, with accurate soundings and shore-lines, there are numerous other points which serve to assist a navigator in traversing unknown waters.

While the traveler on shore may use his sense of sight in avoiding the dangers or obstacles which beset his pathway, the mariner must mainly trust to precarious soundings to indicate to him the profile of the ocean's bottom—the greatest of all dangers.

The bottom of the sea, like the land surface of the earth, is continually changing; and therefore the survey of a harbor or channel-way, although comparatively accurate at the time of its execution, is not necessarily so for all time. Along the Atlantic coast of the United States, for example, the permanency of surveys is extremely poor; and such localities as Hatteras, Lookout, and Frying Pan Shoals, as well as the sand-bars at the entrances of many of the Southern ports, should be resurveyed at least every five years, since in less than that period these shifting sand-spots entirely change in contour.

The wrecking of a steamer upon a shoal, as, for example, that of the British Steamer *Aberlady Bay*, recently stranded upon Lookout Shoals, will in a very short time cause a complete change in the shoals themselves, and their numerous dividing or "slue" channels.

In time of peace, while cruising on foreign stations, there is no better employment for naval vessels than that of discovering new shoals, reefs, etc., or in carefully surveying those shoals and channel-ways whose actual limits are till now but comparatively little known. The surveys are generally made by vessels doing duty on foreign stations, but in some cases, as, for example, the Wilkes Exploring Expedition, in the *Vincennes*, and the Survey of the River Amazon, by Selfridge, etc., vessels are specially detailed for surveying duty.

Although this work is constantly going on, yet, on the other hand, new dangers and obstacles are constantly being discovered, even along routes and in localities which have been for years considered clear of such obstructions. Breakers, shoals and reefs are continually being reported, especially in those sections of the ocean where it has hitherto been impracticable to make other than superficial surveys; and vessels are constantly being sent to search for these reported dangers, to eliminate erroneous reports from correct ones, to determine the exact position and extent of this danger, or else to show absolutely that it does not exist. Frequently the more careful examination of the locality in question proves that that which had been reported as a line of breakers or shoal water must have been the gleam of the sunlight upon the water or the shadow of a passing cloud.

Sea-weed and drifting wreckage have been reported as sea-serpents. In the same way, the ocean abounds with many supposed dangers to navigation which only need closer inspection to prove them harmless.

The settlement of these doubtful dangers, by either placing them accurately upon or entirely expunging them from the chart, is of great importance. The navigator feels more security when he knows that a careful search for that particular obstacle has determined its non-existence or has located it as existing at a certain definite point.

The noting of all changes that occur, the search after undiscovered dangers and the determination of doubtful reports may be called the Care of a Chart, and corresponds to the cleaning and oiling of an engine or the scraping and painting of the metal plates of a modern ocean steamship.

Notwithstanding the care taken in correcting and perfecting ocean charts, the increased number of vessels engaged in ocean traffic, the greater speed at which they now travel and the desire of all nations to extend their commerce to more remote localities, require that to meet these conditions greater accuracy must be attained in chart-making. More vessels, greater competition and quicker passages directly attack the safety of ocean travel; and this state of affairs must be compensated for as much as possible by withdrawing all other sources of danger.

There is little resemblance between the exact navigation of to-day and the hap-hazard voyages of those hardy explorers Hendrik Hudson, Magellan, Gosnold, and Da Gama; or the successful piratical raids of that old free-booter Sir Francis Drake. One hundred years ago the libraries of the world did not contain as much information with regard to the sea as is now annually gathered by the hydrographic office of a single great nation.

With charts that are nearly perfect and with accurately established light-houses, beacons, buoys and other appliances for assisting navigation, it would seem that travel by sea was at this day sufficiently protected.

People still speak of the "trackless ocean," but routes by sea are now intelligently alluded to, exactly described and accurately laid down, the same as trunk lines of railroad are discussed or utilized by the shipper or commercial traveller; and the province of the navigator is now confined to keeping the safest or the shortest known route.

This, by the way, is hardly ever that line which upon the ordinary chart appears to be the shortest distance. For example, for a sailing vessel bound from Gibraltar to New York, the shortest route would be southward and east of Madeira, to a point in long. 30°, lat. 22°; thence along that parallel to long. 60°, thence northward, and west of Bermuda to the Gulf Stream, by which to the vicinity of New York. In point of time, the longest course across the Atlantic would probably be represented on the chart by the line which joins these two places.

Even in the case of a steamer which does not have to depend upon the winds for motive power, the straight line, as shown upon an ordinary Mercator's chart, does not represent the shortest distance between two places. This least distance is measured on the arc of the great circle upon which both places are situated. The shortest distance between Cape Henry and Liverpool, for example, crosses the middle of Newfoundland.

Each nation now vies with others in making the approaches to her ports as secure as possible; and while we spend millions of dollars in the improvement of our harbors, care should be taken to point out existing danger or to publish the fact that the road is a safe one.

The master of a vessel when starting upon a voyage into foreign waters cannot be too well supplied with maritime information. Although the aids to navigation, in the shape of charts and buoys, etc., are now so complete, yet when entering the waters of a strange locality guide-books should be on hand, filled with as complete a description of that place as can be obtained; once arrived in that locality, there is no time to pause for further knowledge; he cannot telegraph to the rear for additional information. All the help that the master can depend upon is that information carried aboard of his own vessel; and this he studies carefully as his vessel approaches an intricate or unfamiliar channel.

Anything is of importance which enables the navigator to make a speedier or a safer passage; for upon these points depends the prosperity of the voyage.

Under the general title of "Sailing Directions" are included all items of information that assist the master of a vessel in making his voyage, ensure the sale of his freight, or give him a better chance of securing a profitable return cargo.

"Sailing Directions" not only state the courses to be steered from one port to another, but describe the prevailing favorable or contrary winds and currents; ice-fields, or other dangers likely to be met on certain courses; tides; depths of water at the entrances to various ports, etc., as well as hundreds of other items of information which may add to the security of the vessel and the quickness of her cruise.

The localities where coal, water, wood, etc., may be procured in the foreign harbors to which he is going; the number and nature of the inhabitants—whether hostile or friendly; the mercantile products that are exported or desired; the best places to anchor, and the facilities for discharging or taking cargo aboard; the periods of the year when local or general gales may be expected—indeed, everything that may add to the knowledge of the navigator, so far as this particular locality is concerned, and which cannot be graphically represented upon the chart is included under the descriptions given in "Sailing Directions."

A complete list of the books showing this information for all parts of the world would be too cumbersome for any vessel to carry and too expensive for the masters of vessels to provide. These books themselves are also subject to the same continual change as are the charts covering the same localities. It is not customary, therefore, for ship-masters to keep copies of sailing directions too long on hand. In many cases it is the custom for ship-owners to provide all such help for the ship-master.

#### BRANCH HYDROGRAPHIC OFFICES.

Owing to the great area of the United States, and the difficulty there would be in obtaining the most recent corrections for charts or sailing directions, branch hydrographic offices have been established in the larger seaboard cities, where are kept complete lists of charts and a full library of all sailing directions. Here the ship-master can depend upon obtaining at all times the latest and most reliable information concerning any port with which he may not be familiar.

Should he have a copy of the necessary chart or book of directions, it can be here compared with the office copy of the same, which latter is constantly kept corrected by the insertion of the very latest received information.

The branch hydrographic offices are located at Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, San Francisco, and Portland, Ore. The charts and books kept here are not for sale, but for reference, and also in order that the officer in charge of the office may be able to give clear and exact information on any maritime subject.

Here is also kept a file of the Notices to Mariners which are constantly being issued with regard to reported dangers, etc. The data for the publication of these notices is here collected and forwarded to Washington, where, after being arranged and printed, copies are sent to all branch offices, from which as centres the information is distributed.

When a change is made in either the character or position of regular aids to navigation, or when information is received of danger existing in the pathway of vessels, a short account of the same is printed under this title of "Notice to Mariners," describing such change or obstacle, and stating what should be done by mariners to avoid trouble from the same. The notice also generally states what steps, if any, are going to be taken to remove this obstruction.

The temporary derangement or discontinuance of a light-house, or the establishment of a new one; the drifting or destruction of any of the various buoys or beacons; the discovery of a shoal or of a superior channel to the one hitherto known and used; the establishment of a new port of entry; wrecks, floating, or sunken in channel-ways, and the placing of buoys to mark new dangers or new channels, are among the many causes which require the issue of such notices.

The hydrographic offices of various nationalities interchange such information, and, therefore, since many notices are received couched in a foreign language, their translation into English is necessary before they can be reissued for the benefit of our merchant marine. In 1890 the United States Hydrographic Office issued 1,171 such notices, covering all parts of the world.

Each branch office is under the charge of a naval officer, who sees that all important information, especially that relating to his immediate vicinity, is at once furnished to steamship companies, shippers, etc., whose interests are thereby affected.

In addition to its publication of charts and the writing,

arranging and publication of sailing directions, notices to mariners, etc., the Hydrographic Office also publishes from time to time other valuable data, such as Ice charts, Pilot charts, Meteorological charts, abstracts of storms and monographs of the more serious meteorological disturbances.

#### DEEP-SEA SOUNDING.

All of our knowledge of the profile and general character of the bottom of the great oceans has been obtained through the medium of deep-sea soundings. By this term is now meant soundings in depths greater than 600 ft.

The operation of laying submarine cables is greatly dependent upon the accuracy with which the profile of the ocean's bottom can be ascertained. The principal difficulty in laying ocean telegraph cables is found to be the danger in great depths of breaking either the cable itself or the insulated covering during the operation of "paying out." After the cable has once reached bottom it has to withstand comparatively little strain.

In order to obtain accurate soundings in great depths, it is necessary to use line of a density that will not counteract the efforts of the sounding-weight. What is desired is an "up and down sounding," as near as may be obtained. A line made of manila or other buoyant substance would not serve for this purpose.

On the other hand, the upper part or surface end of the line used in sounding has to support not only the strain of the sounding-weight, but also of the sounding-line itself, that part of its weight which is not water-borne.

It can thus be seen that at great depths, yet possibly before the weight or cable had reached the bottom, the sounding-line or telegraph cable might break merely from the weight of line that had been paid out. The sounding-weight becomes a matter of small importance, in comparison with the weight of the line itself.

Early attempts at sounding great depths depended, therefore, upon the manufacture of line of great tensile strength and of disproportionately light weight.

An early form of sounding apparatus was that invented by Passed Midshipman Brooke, U. S. N. (afterward Lieutenant Brooke, and the inventor of the Brooke rifled cannon). This apparatus contained the main principle upon which are constructed the more elaborate sounding-machines of the present day.

The Brooke sounding apparatus was in its action similar to the modern hooks used for transporting blocks of ice, and which detach themselves when relieved of the weight they are supporting.

It consisted of three principal parts—a register, a rod and specimen tube, and a detachable "sinker." The register, which was attached directly to the sounding-line, contained two spiral propellers, which, being turned by the water, recorded by clock-work the amount of descent. The rod and specimen tube had at the upper part a hinged link, which permanently joined it immediately underneath the register. The lower end of the rod was a tubular space, in which were vertically fixed a number of goose-quills, which received and brought to the surface specimens of the bottom. The sounding-weight or sinker was a perforated spherical shot resting in a washer supported by wire slings.

After the rod and specimen tube had been inserted through the shot and its supporting washer, the wire slings were brought up and hooked over a small lug upon the hinged link, where they remained secure until the point of the rod touched the bottom, when they immediately unhooked, and sinker and washer were left behind, the register and rod being easily reeled again to the surface.

Many improvements have been made in deep-sea sounding apparatus, notably by Sir William Thompson, F.R.S., and by Commander C. D. Sigsbee and Ensign Harry Phelps, of the United States Navy; and now the greatest known depths are accurately sounded by steamers such as H. M. S. *Challenger* and the U. S. Steamers *Blake* and *Ranger*, that are fitted with the regular modern appliances for deep-sea sounding.

The sounding-line now used is steel piano-forte wire, which, while weighing only about 7 lbs. to the mile, will bear a strain of 400 lbs. without breaking. The amount of descent of the sinker is now shown on the ship's

deck by means of a register attached to the wire-reel, and which records each turn made. A small correction is necessary for the constantly lessening diameter.

The sinker may also be arranged in such a manner as to be undetachable, in which case it is recovered after the sounding has been made. The sinkers vary in weight according to the anticipated depth, while the reeling in is now done by a small engine conveniently placed on deck for that purpose.

¶ With the many modern improvements, it is now possible to take deep-sea soundings with ease and celerity. Ensign Phelps, U. S. N., of the U. S. S. *Ranger*, while using the machine perfected by himself, easily obtained soundings in 650 fathoms with a 40-lbs. lead sinker, the ship starting ahead at a speed of 7 knots as soon as bottom was reached, the reeling in of the wire continuing while under way, and the wire coming in at the rate of about 150 fathoms per minute.

In the North Atlantic, the Caribbean Sea and the Gulf of Mexico our vessels have done much deep-sea sounding, which has greatly increased our knowledge of the various ocean currents in those localities; while several attempts at deep-sea trawling have been quite successful, many specimens of shell-fish and marine plants hitherto unknown having been secured.

To take accurate soundings in depths of from three to four miles, is now a matter of frequent occurrence, and in even greater depths soundings have been obtained.

(TO BE CONTINUED.)

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.\*

### CHEMISTRY APPLIED TO RAILROADS. XV.—HOW TO DESIGN A PAINT.

By C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

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(Continued from page 82.)

OBVIOUSLY the designing of a paint involves sufficient knowledge to answer three questions: First, what kind of pigment shall be used; second, what kind of binding material shall be used; and third, in what proportions shall the pigment and the binding material be mixed?

To those who have not given much study to the question of paints it may seem as though the answer to the question, "What pigment shall be used," is exceedingly simple. The simple answer would be, decide what color you want and then use a pigment which will give you that color. If red is the colored desired use some one of the reds for the pigment; if yellow is the color desired use some of the yellow pigments; if blue is the color desired use a blue pigment; if brown is the color desired use a mixture of red and black; if green is the color desired use a mixture of yellow and blue; and if a gray or a slate

color is desired tone some white with enough of the proper material to give the shade desired, and so on.

But to those who have studied paints a good deal the matter is nothing like so simple. There are a good many questions to be considered in deciding what pigments to use. All pigments do not work equally well under the brush, and all pigments do not dry equally well. Many pigments when mixed with binding material do not behave as it would be thought beforehand they would behave. Many of them are deficient in covering power and devices have to be made use of to overcome this difficulty, and, perhaps more important than anything else, all pigments are not equally durable. With many of them there is apparently a chemical reaction which takes place between the oil and the pigment after it has been on the surface a while, which results in the perishing away, or in the scaling or peeling of the paint. Furthermore, some pigments repel water and some pigments do not. Some pigments grind well and some do not, and, finally, some pigments are extremely expensive while others are very much less so.

In view of these statements it is obvious that the selection of the pigment in a paint to be used generally is not so simple a matter, and that in order to do this work intelligently and wisely, and secure good results at the least possible expense, an intimate knowledge of pigments is essential. Our experience with pigments has been more limited than we could wish, and we do not at all feel that we should be able to convey in the present article information sufficient to enable one unskilled in the art to use all pigments wisely in making paints. We do hope, however, to be able to give one or two laws which, so far as our experience goes, have pretty broad if not universal application.

It will be understood that the ground covered by this article is confined almost exclusively to house-painting. In carriage-painting, the use of pigments is almost exclusively for the sake of the color, and the use of the binding material is simply to hold the pigment to the surface. Questions, therefore, of durability or economy are very much less important in carriage-painting than in house-painting, where the paint is relied on not only for the color but also for protection, and where its expense must be likewise carefully considered.

It will be remembered that in the articles which have preceded we have discussed (1) the durability, (2) the working qualities, (3) the drying, and (4) the covering power of paints, and have tried to set forth in those articles what we regard as essential under the various heads. All these four properties are essential in order to have a good paint. There is a fifth quality which must not be forgotten, and especially in the discussion which we are about to enter upon, and that is (5) the cost. What is really wanted from the standpoint of the consumer, at least, is that the paint shall have the four qualities mentioned above, at the very minimum of cost. In what follows we will try to bear in mind each of these five essential requisites.

In answering the question, What pigment shall be used, the subject naturally divides itself into two branches, namely, first, where pigments of the color desired, and which fulfil the five requisites mentioned above, can be obtained in the market, and, second, where the desired colors cannot be obtained in pigments which fulfil the five requisites above. As examples of the first of these cases we may mention the various shades of red produced by the numerous oxides of iron, also the yellows produced by the ochres, the browns produced by the umbers and Siennas, and the blacks produced by ivory black and lamp-black. With a modification which will be discussed at some length a little farther on we will say that where the color desired is so simple as any of the above, or where a pigment which has the proper durability, working qualities, drying properties, covering properties, and cost can be found of the desired color, the choice of the pigment is extremely simple, and the answer to our question of what pigment shall be used is not at all difficult to find. But with a very large portion of the paint used, exclusive of carriage-painting, the question is nothing like so simple as this, since the shades desired cannot be found embodied in a single pigment which satisfies the five requisites. To answer the

\* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, are on Petroleum Products; No. VII, in the June number, is on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number on the Covering Power of Pigments. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

question as applied, therefore, to tints and shades, which is a large percentage of all the painting, it will be necessary to go a little deeper.

There is, however, one preliminary question which must be discussed before we can enter on this field, and that question is, "Is it necessary and wise in painting to use pigments as pure and unmixed with any other materials as it is possible to get them, or with various pigments can a certain amount of inert matter be wisely used as a constituent?" For example, is it wise and essential when using red lead as a pigment to have the pigment all red lead? Is it wise and essential when using white lead as a pigment to have the pigment all white lead? Is it wise and essential when using oxide of iron as a pigment to have the pigment all oxide of iron, and so on? We have studied this point a great deal and have made a large number of experiments, and the successful answer to this question, it seems to us, involves still another question, namely, if the pigment is strong in coloring power, as is the case with oxide of iron, with lamp-black, and with other pigments which might be mentioned, is it better to dilute with liquid and thus make a given amount of paint cover a larger amount of surface, or is it essential for the durability and success of paints that the surface should be covered with a large amount of pigment. It is obvious that if with a given amount of paint of oxide of iron or lamp-black a very much larger amount of liquid is mixed in one case than another a very much larger amount of surface will be covered in one case than in the other, and it is also obvious that the amount of pigment per square inch or square foot will be very much less in one case than the other. We have known very many practical men to claim as one of the advantages of the material which they furnish that it would bear dilution of this kind with liquid and still cover the surface well. Our experience confirms this statement, namely, some of the oxides of iron are so strong in covering power that they can be very largely diluted with liquid and still cover the surface excellently well; but the query arises, Is the surface as well protected, and will a paint of this kind, namely, one in which the amount of pigment per square inch or square foot of surface is small be as durable and as satisfactory in other respects as one in which the amount of pigment per square inch or square foot of surface is very much larger? To this question we answer emphatically, It will not. All our experience and experiments for now some three or four years, show conclusively that the amount of pigment per square inch or square foot of surface is one of the elements in the durability of the paint. Freight cars painted with 25 lbs. of freight-car color paste look well and have a good coat of paint on them at the end of three or four years, while cars painted with 12 to 15 lbs. of freight-car color paste begin to look badly at the end of the second year and the layer of paint is thin and the car has an old and worn appearance. We have very little hesitation in saying, and we think all experiments honestly made under proper conditions will prove this point, namely, that it is essential for a good paint that the amount of pigment per square inch or square foot of surface should be large.

This may look like making the durability of the paint depend on the pigment, whereas the common idea is that the oil is the life of the paint. We are quite free to confess that in our experience we have not been able to confirm the common belief among paint manufacturers and, indeed, among many of the users, that the oil is the life of the paint. The pigment is the life of the paint according to our experience. In reality the pigment protects the oil from decay if it is present in proper amount and, still further, is of the proper kind. A single thought seems to us to have very much weight in this connection, namely, with such pigments, for example, as oxide of iron, which undergo no chemical change in centuries of exposure, it is obviously the oil which decays and wastes away. Even though the pigment has fallen off from the surface it is still oxide of iron and is unchanged. Not so with the oil, it is constantly undergoing slow decomposition, and in reality the wear and wasting away of paint is largely the decay of the oil. This statement, of course, only holds true where there is no chemical action between the oil and the pigment. These cases we will treat farther on. It is sufficient for our pur-

pose here to put clearly on record that we regard it as an essential of good paint that the amount of pigment per square inch or square foot of surface should be large. We will, later on, when we come to discuss the question of the relative proportions of oil and pigment, give some figures on this point.

If this statement be granted, we are now ready to discuss the other question, namely, although it is essential that the amount of pigment per square inch or square foot of surface should be large, is it essential that this pigment should be all of the characteristic kind that is used to give the color desired? For example, although it is essential to have a large amount of pigment on the surface painted with oxide of iron, is it essential that all, or nearly all, of the pigment should be oxide of iron? We unhesitatingly say, It is not, and are quite aware that in making this statement we are laying ourselves open to the accusation that we are opening the door to all kinds of adulterations and admixtures and inferior results in paints, but we do this with our eyes wide open. We are confident that it is not essential to use pure pigments, except as will be mentioned later on. We believe greater durability, fully as good working qualities, equally good drying qualities, sufficiently good covering power, and diminished cost can be obtained by mixing inert materials with other pigments where they will stand it than will be obtained by using as pure materials as can be obtained in the market. For example, it is well known by those who have spent any time on this subject and made any experiments, that if any good oxide of iron is mixed with sulphate of lime, carbonate of lime, barytes, kaolin, silica, talc, or pulverized feldspar, in the proportions of about  $\frac{1}{4}$  oxide of iron and  $\frac{3}{4}$  of any one of the above inert materials and a paint made of this which gives the proper amount of pigment per square inch or square foot of surface, the surface will be well covered with the red, and the same thing is true, in a modified way, with a number of other pigments which are strong in covering power. To state the problem again, we will say that the real question seems to be, first, suppose one ounce of oxide of iron, in two coats, will cover two square feet of surface so that the surface will be completely hidden, and any painter would pronounce the job a satisfactory one so far as covering power goes; second, suppose now a contiguous two square feet had one ounce of the same oxide of iron on it, but in addition it had three ounces of inert material, such as barytes, gypsum, kaolin, etc., or any one of them mixed with the oxide of iron, the whole being spread in two coats as before. Obviously the amount of color per unit of surface would be the same in both cases, but in one case there would be four times as much pigment as in the other, and in the second case three-fourths of the pigment would be inert material. We say the question is, which of these two paints would have the greatest durability? We have no hesitation in saying that the second one would, and all our experiments confirm this view.

We are thus explicit in stating this point because, as said above, many manufacturers and many painters hold diametrically opposite views. They think pure materials alone should be used, but as we will try to show later, there are very great disadvantages connected with the use of certain pure materials, which disadvantages are modified by the use of inert material along with the pure pigment. We are quite well aware that this opens the door for adulterations so called, but our answer to this is that when people become so informed on the subject that their demand for absolute purity has passed away, for the reason that better paints are obtained by using durable inert materials as constituents than by using perishable pure materials, then there will be no adulteration, because the manufacturers will sell their paints exactly as what they are. They will not claim to sell pure paints, but will give the formula if it is cared for. Moreover, as long as a man knows what he is buying, and is not charged the price of pure materials for mixed materials, there is no adulteration.

This question of inert materials is so important in our judgment, that we may be pardoned for devoting a little space to it, as we are quite prepared to believe that a very large number of people interested in painting would hardly be willing to accept our first proposition, namely, that greater durability and less cost, with no detriment to working

properties, drying and covering qualities, can be obtained with the use of inert material along with the pigment than if this pigment is used pure and simple. However, we are so well satisfied upon this point that we are ready to discuss one or two questions connected further with inert materials, namely, first, What inert material shall be used and, second, how much of it shall be used? At present there are available in the market seven or eight different kinds of inert materials, as follows: Whiting, ground gypsum (also known as American terra alba), barytes, kaolin (or pipeclay), ground silica, ground talc, ground feldspar, and possibly asbestos may be added, although according to our experience much of that which passes as asbestos is nothing in the world but ground talc, or some related rock. We have experimented with each of these inert materials more or less and find them all extremely deficient in optical covering power; indeed, a board painted with any one of these ground into a paint looks almost the same as though it was not painted at all so far as optical appearance or behavior is concerned. They are all whites, as is well known, except as they may be contaminated more or less with a little oxide of iron or other minerals imparting a little color or tint to them. Taking them up one after the other we will give a few points in regard to them. Asbestos of the fibrous nature we have never seen in paint of any kind and have very little experience with it. As said above, most of that which passes as asbestos is ground talc, or soapstone, or some related rock, so far as our knowledge goes. Feldspar we have never felt inclined to largely use on account of its ready decomposition when exposed to the weather. It is recognized that many of the clay beds of the country now used for making fire-brick are simply decomposed and broken down feldspars, and a pigment, or anything in a pigment in paints, which is not durable and unchangeable when exposed to the weather, is certainly to be avoided. Talc we have experimented with quite a little and find that it does not grind well, and in almost any proportion with any pigment with which we have mixed it it makes a paint which does not seem to adhere well. It is in this respect much like kaolin, which all practical painters say grinds greasy, and while in many senses both kaolin and talc are valuable and may be used in special cases, especially where the main pigment is inclined to be granular, we do not recommend either of these very highly. Ground silica, so far as our experiments go, is unobjectionable, except that it is very hard on the mill, and difficult to get in a fine state of division, which is one of the great essentials of a good paint. This leaves barytes, gypsum, and whiting. So far as barytes is concerned, we simply say that we have no objection to it except its great specific gravity and its cost. A pound of barytes will go a very little distance in a paint. Obviously if paint is bought and sold wholly by the pound, it is very advantageous to the manufacturer to use as much barytes as possible, but the use of paints is by volume and, consequently, it is very disadvantageous to the buyer to have so heavy a pigment a constituent of the paint which he buys. There are many valuable qualities in barytes, especially its great durability, but we query whether the paint manufacturers themselves fully understand what they are dealing with when they use barytes. Our position is that we cannot afford to use it, and we will make the statement that no manufacturer who sells his paint by the gallon can afford to use it either. Of course, if he sells his paint by the pound he can afford to use it, but not otherwise, and to the trade we would say, if you will give us the same number of particles of barytes of the same size, for the same money, that you will of sulphate of lime, or whiting, you may use barytes in making our paints. How impossible this is may readily be seen from knowing that each particle of barytes weighs twice as much as a particle of the same size of sulphate of lime, or American terra alba, and costs fully twice and possibly three times as much. As a suggestion to those who are selling ready mixed paints, we would say, calculate the cost of a gallon on your present formula, if you are using barytes as inert material, and then calculate the cost of a gallon, substituting American terra alba, or gypsum for barytes, and we are confident the use of barytes as inert material in mixed paints, at least, will entirely disappear.

In our discussion of inert materials this leaves us now only two substances, namely, whiting and gypsum, both of which have valuable qualities and both of which have difficulties connected with them. We have thus far always favored the use of gypsum instead of whiting, although we are quite well aware that a number of manufacturers prefer the whiting to the gypsum. We do not feel quite satisfied to say anything very positive in regard to whiting as yet, for our fear has always been of chemical reaction between the oil and the whiting, resulting in the formation of a lime soap, which is not at all durable. On the other hand, putty, which is a mixture of whiting and oil, is an extremely durable substance. We have experiments in progress, but not yet ready to gather conclusions from, as to the relative durability of sulphate of lime or gypsum and whiting as constituents of paints. Within a year or two we will probably have positive information as the result of experiment, but at present the best we can say is that we are afraid to have whiting a large constituent of any paint. This brings us down to sulphate of lime and, all things considered, we know of no material which has so many good qualities and so few difficulties connected with it as sulphate of lime. The only objection to sulphate of lime is the fact that it is a hydrated material, that it has as a part of its chemical composition two molecules of water. During grinding the heat caused by friction is sufficient to drive off a portion of this chemically combined water, and if perchance this water is taken up again before the paint is spread there is a tendency on the part of the paint to become a liver, a phenomenon which is familiar to all old painters. We hope ultimately to discuss the livering of paint somewhat at length, and will only say here that, with the single prerequisite that a little water should always be added to the paint during grinding, where sulphate of lime is an important constituent of the paint, we know of no difficulties which will arise from the use of sulphate of lime as an inert material in paints. Much could be said in its favor, especially its great durability, its chemical inactivity, and its very light specific gravity, and its low cost.

This brings us to the question of how much inert material shall be used. Of course this question is an extremely difficult one to decide. In one case which we have already mentioned we are quite ready to allow as much as three parts of inert material to one part of the characteristic coloring matter. It is obvious, however, that this rule would not be universal, and it is likewise obvious that each pigment has its own characteristic amount of inert material that it can bear. We have obtained excellent results in covering with lamp-black one part and sulphate of lime nine parts by weight. On the other hand, with some of the pigments one part of inert material and one part of the characteristic pigment do not give satisfactory results, and some pigments will not bear any.

The law as we understand it is this: You may use as much inert material as will leave you good optical covering power when the paint is properly mixed and applied. In our experience white lead alone will not bear to be mixed with inert material in equal parts. This also is the case with white zinc. Unfortunately we have not experimented with all pigments and cannot give proportions for all pigments, but there are other points which must be kept in mind. First, the amount of inert material which can be used depends on the fineness of the grinding. The finer paints are ground the more inert material can be used without seriously interfering with the covering power, and those pigments which in their nature are extremely fine will bear more inert material than those which are not fine. Second, the amount of inert material which can be used depends, all other things being equal, on how the paint is mixed. If the paint is so mixed that the coat is very thin less inert material can be used than if the paint is so mixed that the coat is thicker. When we come to discuss the relative proportions of pigment and liquid we will give our experience and practice on this point. The third point is, no inert material must be used which has a possible chemical reaction between itself and the main pigment. Upon this point the information is not as definite as could be desired. We have experimented with mixtures of sulphate of lime and white lead, but are not absolutely positive that any chemical reaction takes place. We have also experi-

mented with white zinc and sulphate of lime, but are unable to prove that chemical reaction does take place. It is well known that chrome yellow, and mixtures of chrome yellow and Prussian blue giving a green, fade readily. We have never fully satisfied ourselves as to whether this fading is due to reaction between the inert material and the other pigments, or between the pigments themselves, or between the oil and the pigments, but it is obvious that if it is possible for any chemical change to take place between the inert material and the other pigments that inert material should not be used with those pigments.

We have taken so much space in discussing the inert material that we have left ourselves only small room for answering the question, "What pigment shall be used?" We have already, however, fairly well, we think, covered the ground where a pigment of the desired shade can be obtained. We will, therefore, only say here that in these cases the rule is that where the pigment which gives the desired shade can be obtained, be it oxide of iron, ochre, umber, Sienna, or what-not, use these pigments and add to them as much inert material of the proper kind as they will bear, due regard being given to the optical covering power. The question of tints for which there is no characteristic pigment remains still to be discussed.

Upon this point we will say that the basis of all tints must be some pigment which has good covering power, and in delicate tints must necessarily be a white, since in all the pigments which have good covering power the strong characteristic colors cannot be used as the foundation of any tints except those in which their own color predominates. A good white, therefore, is essential as the basis for tints. Unfortunately only two fairly good whites, and neither of them satisfactory, are known to exist. These are white lead and zinc white. Both of them are inferior in covering power, both of them very greatly lack in durability, and both of them are moderately expensive. The lack of durability of these two pigments manifests itself apparently in diametrically opposite ways. White lead crumbles and powders away apparently as the result of chemical action between the pigment and the oil, and is readily decomposed and blackened by sulphur gases in the air. Zinc white likewise apparently combines chemically with the oil, but instead of powdering peels off in flakes, and the action of sulphur gases if it takes place at all does not result in blackening, obviously because the sulphide of zinc is white. It is a very great misfortune that there is no white known which has greater covering power and greater durability than either zinc white or white lead, and although neither of them is satisfactory, there seems to be no alternative at present except to use them as best we can. Our experience in absolute durability of these pigments is not as great as we could wish, although we have experiments in progress. We are therefore not able to give as positive information as we could wish on the subject. We are inclined to mix the two pigments rather than to use either one alone, especially for outdoor work. The proper mixture of white lead and zinc white being decided on—and in our experiments we have used equal volumes of the two—to secure the tint that is desired, use such tinting materials as may be necessary. If a reddish yellow is desired a little ochre and a little oxide of iron will give the desired color. The brown tint is readily obtained by mixing red and black. The proportions and kinds of pigments to be used to secure the various colors are a part of the art of the manufacture, and do not enter into the discussion here further than to say that no materials should be used between which there is a possible chemical reaction in water solution—that is to say, if you put two pigments together in water and they mutually decompose each other these pigments should never be used in the same paint.

The various tinting materials to be used have different covering power. For example, if a fairly strong percentage of chrome yellow is used in securing the tint the covering power will be greatly improved; so also if any considerable amount of lamp-black or iron oxide is used the covering power will be greatly improved. In these cases it is always possible to use more or less inert material with, as we believe, increased durability and diminished cost in the paint. The law for tint, therefore,

would seem to be as follows: Use a mixture of white lead and zinc white, possibly in equal quantities, as a basis. Add to this the necessary materials to produce the tint desired, and then add all that the material will bear of inert material—preferably, so far as our experience has gone, sulphate of lime.

The discussion in the foregoing article may perhaps be summed up as follows: In answer to the question, "What pigment shall be used?" we say, first, if there is any pigment not too expensive of the desired color use this pigment, and add to it as much inert material as it will bear without interfering seriously with the covering power; second, if there is no pigment of the desired color use a mixture of white lead and zinc white half and half by volume as the basis, add to this the necessary tinting materials, and then add as much inert material as the mixture will bear without interfering with the optical covering power; third, do not mix pigments which have any possible chemical reactions between themselves in water solution, and do not add to any pigment any inert material between which and the pigment there is any possible chemical reaction in water solution.

In the next article we will discuss what liquid shall be used and also the proportions of pigment and liquid.

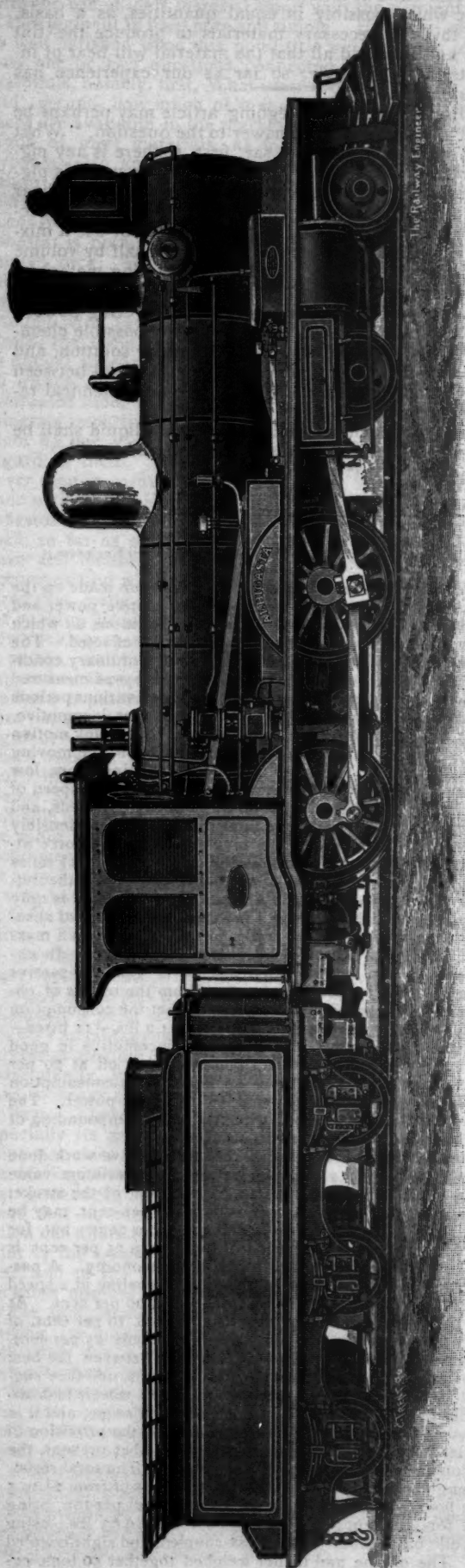
(TO BE CONTINUED.)

### Experiments on Train Resistance.

(M. Desdouts in *Proceedings of the Institution of Civil Engineers.*)

FOR several years many experiments have been made on the State Railroads of France to determine the motive power and resistance of trains, in order to settle the conditions on which the greatest economy of motive power may be effected. The trials were made with trains in service under ordinary conditions. The power developed in the locomotive was measured by means of the indicator for various speeds and various periods of admission. In one instance—of a passenger locomotive, having 17.3 in. cylinders, 26 in. stroke, with Allan's link motion—it was shown that, for all degrees of admission, the moving power increased as the speed increased, starting from low speeds, until the maximum power was developed at a speed of about 21½ miles—35 kiloms.—per hour. For higher speeds, and for all degrees of admission, the power decreases very sensibly as the speed is increased. The maximum effective force attained with 70 per cent. of admission at a speed of 21½ miles per hour is 11,000 lbs.—5,000 kilogs.—for which the "theoretical" effort is 12,480 lbs.—5660 kilogs. The difference is only 12 per cent., of which, allowing 3 per cent. for the loss of absolute effort due to wire-drawing and compression, there is a maximum of 9 per cent. absorbed by passive resistances. In engines having piston valves with Walschaerts' gear the passive resistances do not exceed 7 per cent. From the results of observation, taken together, it is established that the consumption of steam, including moisture, is less than 24.2 lbs.—11 litres—per effective horse-power in a passenger locomotive in good condition; with steam of 9 atmospheres, cutting off at 20 per cent. at moderate speed—31 miles an hour. The consumption of fuel of good quality is about 2.68 lbs. per horse-power. The author argues that the economy effected by the compounding of locomotives can hardly exceed 10 per cent.

From various data it is deduced that the effective work done per unit of steam, for all speeds, attains its maximum value when the steam is cut off at about 20 per cent. of the stroke. At low speeds an admission approaching 30 per cent. may be practised, or it may be a little less than 20 per cent.; but, for considerable speeds, an admission of from 20 to 25 per cent. is to be adhered to in order to attain maximum economy. A passenger engine attains maximum economy, traveling at a speed of from 25 to 30 miles per hour, cutting off at 20 per cent. At a speed of 37 miles per hour there is a loss of 10 per cent. of efficiency; at 43 miles per hour the loss exceeds 25 per cent. These results point to a want of harmony between the best speed for economy and the usual working speeds, and they suggest that an augmentation of the diameter of the wheels is desirable. But this expedient does not afford much scope, and it is more likely that the removal of inside lap, or the provision of inside clearance, would reduce, if not altogether prevent, the diminution of efficiency at the higher speeds. The total resistance of engines with their tenders, at low speeds of from 2½ to 5 miles an hour, varied from 6.94 lbs. to 10.64 lbs. per ton, using colza oil for lubricant; and from 5.82 lbs. to 9.63 lbs., using naphtha oil; having four-coupled, six-coupled, and eight-coupled wheels. The engine and tender weighed together 50 tons, ex-



COMPOUND PASSENGER LOCOMOTIVE, ARGENTINE GOVERNMENT RAILROADS.

cept in one instance 70 tons. The resistance of the mechanism alone varied from 1.87 lbs. to 3 lbs. per ton. Tenders alone have a resistance of from  $5\frac{1}{2}$  lbs. to 6.2 lbs. per ton; the resistance of the engine alone is from 7 lbs. to 8.8 lbs. per ton.

The author directs attention to "an extremely important element of resistance"—the reaction of the surrounding atmosphere—the greater portion of which applies directly to the locomotive, the resistance of which, with high-speed trains, amounts frequently to more than half the total resistance. Two engines, of which the resistance was measured separately and found to be 19.8 lbs. per ton at 37 miles per hour, were coupled together and again tried. The resistance fell to 14.3 lbs. per ton; the second engine was masked by the first. It is argued that by a suitable adaptation to the front of the engine a saving of from 8 to 10 per cent. of the effective power could be made. The resistance of carriages and wagons, weighing, empty, 10 tons and  $7\frac{1}{2}$  tons respectively, was found to be  $3\frac{1}{2}$  lbs. per ton at low speeds. Further deductions are made from numerous experiments.

#### AN ARGENTINE COMPOUND LOCOMOTIVE.

THE accompanying illustration, which is taken from the London *Railway Engineer*, represents one of 11 compound engines of the Worsdell-Von Borries system for the Argentine Government Railroads. The engines are for a railroad of one meter gauge, having minimum radii of curvature of 984 ft., and are built to burn wood. They are, as will be seen from the engraving, of the eight-wheel or American type, having a four-wheel truck forward and four driving-wheels.

The boiler, which is built to carry a working pressure of 175 lbs., is 46 in. in diameter of barrel and has 135 brass tubes 2 in. outside diameter and 10 ft. 6 in. in length. It has an extended smoke-box of a somewhat clumsy looking pattern and of unusual length, 4 ft. 9 in. outside. The fire-box, which is of copper, is 78 in. in length and  $26\frac{1}{2}$  in. wide inside.

The high-pressure cylinder is 15 in. in diameter and the low-pressure cylinder  $21\frac{1}{2}$  in., the ratio therefore being 1:2.06. The stroke is 22 in. The low-pressure cylinder has steam-ports  $16\frac{1}{2} \times 1\frac{1}{2}$  in. and exhaust-ports  $16\frac{1}{2} \times 2\frac{3}{8}$  in., the slide-valve having 1 in. outside lap. The high-pressure cylinder has steam-ports  $11\frac{1}{2} \times 1\frac{3}{8}$  in. and exhaust-port  $11\frac{1}{2} \times 2\frac{1}{2}$  in., the slide-valve having also 1 in. outside lap.

The driving-wheels are 54 in. in diameter and the truck-wheels 30 in. The center of the boiler is 5 ft. 9 in. above the rails. The frames are of the plate type, and are of  $\frac{3}{4}$ -in. steel. The driving axle journals are  $6 \times 8$  in. and the truck axle journals  $4\frac{1}{2} \times 9$  in. The total weight of these engines is 58,400 lbs. empty, of which 48,500 lbs. are carried on the drivers and 9,900 lbs. upon the truck. The weight in working order is about 70,000 lbs.

The tender is carried upon six wheels provided with radial axle boxes. Its weight, light, is about 19,000 lbs. The tender wheels are 33 in. in diameter. The capacity of the tank is about 2,100 gals. of water.

These engines were built by Sharpe, Stewart & Company in Glasgow, Scotland, and in addition to the 11 passenger engines the same company is building 27 freight engines, which are also eight-wheel compound engines, but are somewhat heavier than those intended for passenger service.

#### THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.

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(Continued from page 134.)

##### CHAPTER X.

##### SHADE AND SECTION LINES.

WHEN light falls on one side of an object, as every one knows, the side nearest to the light is illuminated and that farthest from it is in shadow. To indicate this effect in outline drawings, it is customary to make the lines on the shaded side of objects heavier than those on the illuminated sides, which suggests, although it does not correctly represent, the effect of light as we see it in nature.

In drawing such *shade lines*, as they are called, the light, for the sake of explicitness, is always supposed to fall upon the object in parallel lines, as explained in Chapter IV, and to produce the maximum effect on the shaded vertical and hori-

zontal lines and surfaces of the objects represented, the light is supposed to fall obliquely from the upper left-hand corner of the sheet of paper toward the lower right-hand corner at an angle of  $45^\circ$  to the vertical and horizontal lines of the drawing.

Fig. 226.

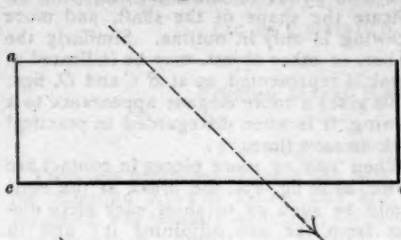


Fig. 227.

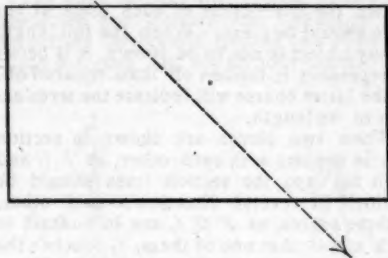
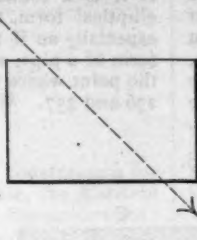


Fig. 228.

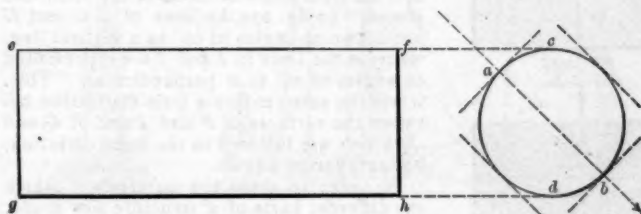


Fig. 229.

Fig. 230.

Scale 3 in. = 1 ft.

exposed to the light, and  $b d$  and  $d c$  are shaded. Consequently the first two are represented by light lines and the latter by dark or heavy lines. The sides in the end elevation, fig. 227, and the plan, fig. 228, are similarly drawn.

Fig. 229 represents a side view of a cylindrical-shaped object, and fig. 230 an end elevation of it. In the latter view the light is again supposed to fall in the direction of  $45^\circ$  to vertical and horizontal lines, as indicated by the dotted dart. At  $a$ , in the end view, the surface of the cylinder is at right angles to the dart, and therefore this is the point of greatest illumination, or the *highest light*, as it is called. At  $b$  the surface is again at right angles to the direction in which the light falls, but it is opposite to the light, and for this reason is in the darkest shade. As the angle which the surface of the cylinder bears to the direction in which the light falls increases from  $a$  to  $b$  on both sides, the outline in this view should be lightest at  $a$  and darkest at  $b$ , and should gradually increase in darkness from  $a$  to  $b$  on both sides of the cylinder.

To draw the outline of the end view, a very light circle should first be drawn, being careful in doing this to make as small a prick mark for a center with the compasses as possible. If the circle is of considerable size, say an inch or more in diameter, it is best to take another center slightly nearer to  $b$  than the original center was. Then draw part of another fine circle on the shaded side from the new center. This second circle will be slightly eccentric to the first one. The space between the two circles may then be filled with ink by gradually increasing the distance between the points or nibs of the compass pen. Some skill is required to do this neatly, and the student will probably fail in doing it at first; but a little practise will teach him the required "knack."

If the circle is smaller than an inch in diameter, its circumference may be drawn heavier on one side than the other by pressing gently with a finger of the left hand against the point of the compasses, thus pushing it slightly in the center prick mark toward the shaded side of the object. Some skill is also required to do this neatly, but it is easily acquired with a little practise.

In fig. 229 the lines  $e f$  and  $g h$  represent the surfaces of the cylinder shown at  $c$  and  $d$  in fig. 230. It will be noticed that the outline at  $c$  is only slightly heavier than it is at the most highly illuminated point at  $a$ . Consequently  $e f$  should be drawn only a *very little* heavier than a line which

Fig. 235.

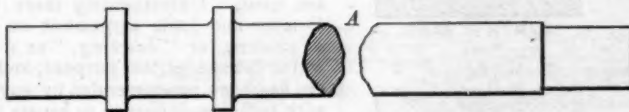


Fig. 236.

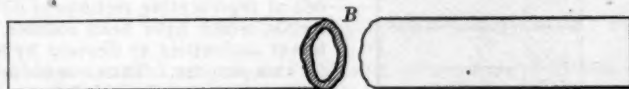


Fig. 237.

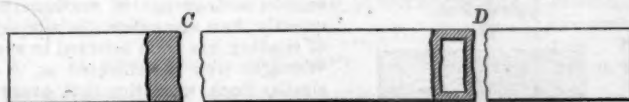


Fig. 238.

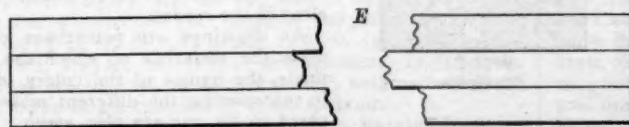
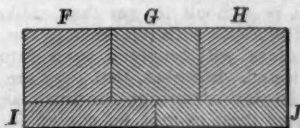


Fig. 239.



All the parts may therefore be shaded according to one uniform rule. Thus, in figs. 226, 227 and 228, which are side and end views and a plan respectively of an ordinary brick, the light is supposed to fall in the direction of the dotted darts. It is plain that when this occurs, that the sides  $a b$  and  $a c$ , in fig. 226, are

Fig. 231.



Fig. 232.

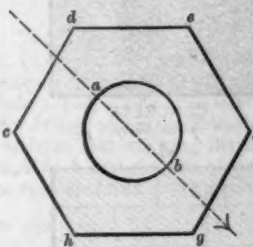


Fig. 233.

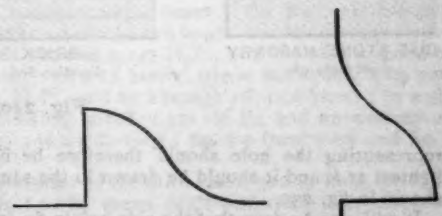


Fig. 234.

would represent the most highly illuminated part of the cylinder. At  $d$  the outline is very nearly, but not quite, as heavy as at  $b$ , where the surface of the cylinder is in the deepest shade. Therefore the line  $g h$  should be drawn as heavy as the circumference of the circle is represented at  $d$ , in fig. 230.

It must be admitted, however, that this proportioning of lines is a refinement that is seldom observed in practical work. In some books on mechanical drawing, it is held that lines, like *c f* and *g h*, which represent surfaces, as *c* and *g* seen edgewise—and not intersections of surfaces, as the outlines of the brick in figs. 226–228 do—should never be represented by heavy lines. The reasoning in support of this opinion does not seem to have enough force to sustain the practise.

Figs. 231 and 232 represent an ordinary hexagonal blank nut—that is, a nut without the thread cut in it. From the plan, fig. 232, it will be seen that the side of the hole at *a* is in the deepest shade, and at *b* it is in the highest light. The circle

As\* explained in Chapter V, in representing any objects, such as shafting, which are too long to admit of being shown full length to the scale on which the drawing is made, the ordinary way is to show it as if broken off. The break can be made in the middle of the length, as shown at *A*, fig. 235, or at any other convenient place, depending on its surroundings. If it is a round shaft, it is better to show the section of an elliptical form, to indicate the shape of the shaft, and more especially so if the drawing is only in outline. Similarly the form of a pipe, square bar, or other object, may be indicated at the point where the break is represented, as at *B C* and *D*, figs. 236 and 237. While this gives a more elegant appearance to a drawing, it is often disregarded in practical work to save time.

When two or more pieces in contact are shown, as in fig. 238, the break at the ends should be such as to show each piece distinct from the one adjoining it; and in showing a portion of iron plates, as in figs. 157 to 160, where two or three are joined together, the distinction of each plate at the ends should be clear. When the full length of any object is not to be shown, it is better to represent it broken off than squared off, as the latter course will indicate the termination of its length.

When two pieces are shown in section and in contact with each other, as *F G* and *H* in fig. 239, the section lines should be inclined in reverse direction to each other. If three pieces, as *F G I*, are in contact in such a way that one of them, *I*, touches the other two, its section lines should be drawn at a different angle to those of the other two pieces. In fig. 239 the lines of *F G* and *H* are drawn at angles of 60° to a vertical line, whereas the lines in *I* and *J* are represented at angles of 30° to a perpendicular. This, it will be seen, makes a little distinction between the surfaces of *F* and *I* and of *G* and *J*, which are inclined in the same direction, but at different angles.

In order to show the materials of which the different parts of a structure are made, conventional methods of drawing shade lines and combinations of different kinds of lines are used. Unfortunately there is no uniformity and little agreement on the kinds of shading, or "hatching," as it is called, which is used for this purpose, and no standard has been recommended by any authority with sufficient influence to secure its general adoption. Fig. 240 shows symbolical methods of representing sections of different materials, which have been collated from different authorities or devised by the author for this purpose. Thus a section if shaded, as shown at *A*, is intended to represent cast iron. As this material is represented in section in drawings of machinery more frequently than any other, the simplest method of shading has been selected to symbolize it. Wrought iron is indicated at *B* and with similar lines, excepting that every alternate line is heavier than those which adjoin it. No other explanation is needed to make the uses of the other surfaces, shown in fig. 240, clear to the reader.

As drawings are sometimes colored to show the materials of which the parts are made, the names of the colors to be used in representing the different materials indicated in fig. 240 are also given. In selecting these simple colors and not mixtures have been chosen. When combinations of tints are used it is difficult to get them alike at different times. Further directions with reference to the method of applying and using colors will be given in a future chapter. It may be mentioned, however, that they are not employed in making mechanical drawings as much as they were formerly. The fact that they cannot be copied in the process of blue printing—which will be described hereafter—and in photo-engraving has lessened their use very much of late years. It may also be

\* Much of this and the following paragraph is quoted from "The Workman's Manual of Engineering Drawing," by John Maxton.

### SYMBOLICAL SHADING AND COLORS.

For Cross Sections of Different Materials.

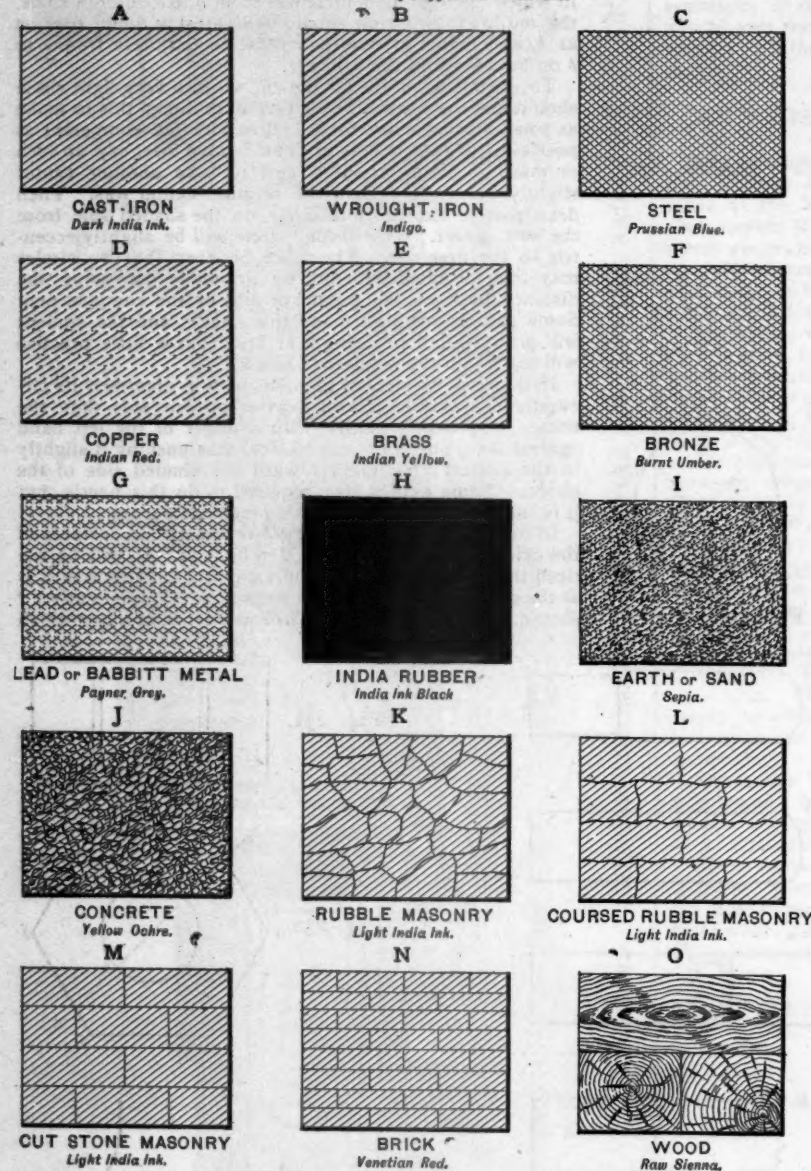


Fig. 240.

representing the hole should therefore be heaviest at *a* and lightest at *b*, and it should be drawn in the same way as the one shown in fig. 230.

It will also be seen that the side *c d*, in fig. 232, is exposed to the strongest light, *d e* is illuminated less, and *c h* still less, and *h g*, *g f* and *e f* are in shadow. The width of the lines representing these sides should be proportioned to their illumination. The same rule applies to the vertical lines representing the intersection of the sides in fig. 231. Every shade line should be of a thickness regulated by its being more or less from the light side, as shown in figs. 229–232 and in figs. 233 and 234.

mentioned that more importance has been assigned by writers on the use of symbolical methods of shading and coloring sections than the subject seems to deserve. Usually there is no uncertainty concerning the materials of which the different parts of a machine or other structure represented in a drawing are made. If there is, it is always best to designate by writing on the drawing the material to be used.

(TO BE CONTINUED.)

### Foreign Naval Notes.

#### AN AUSTRIAN CRUISER.

Two new protected cruisers are now under construction for the Austrian Navy at Pola. The first of these, the *Kaiserin Elizabeth*, was recently launched; her principal dimensions are: Length, 339 ft.; breadth, 40 ft. 6 in.; mean draft, 18 ft.; displacement, 4,060 tons.

The main battery will consist of two 9-in. guns mounted in barbettes, one forward and one aft, and six 6-in. guns. The secondary battery will include two 2½-in. Uchatius guns, eleven rapid-fire guns, and six torpedo-tubes.

tricity, not only for lighting, but for running the motors which operate the turrets, hoist the ammunition and assist in loading the guns. The application of the electric motor will be more extensive than in any French ship yet built.

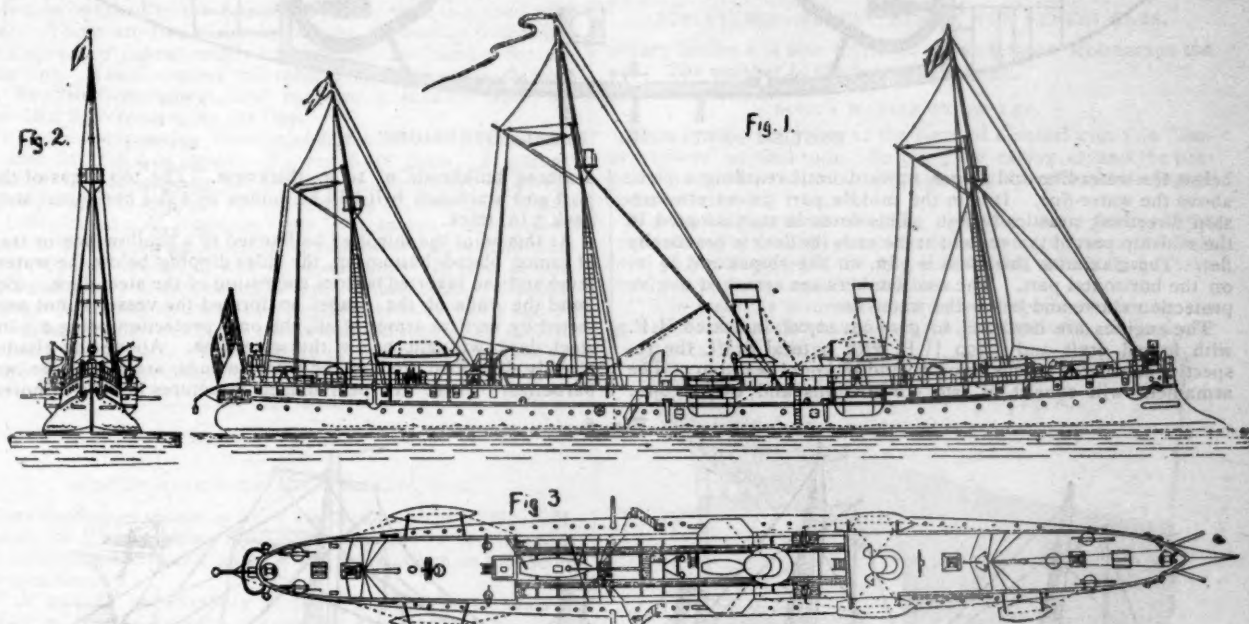
Another peculiarity will be that the steam power will be furnished by tubulous boilers. The ship will have 24 d'Allest boilers, which will carry a working pressure of 210 tons. This boiler was described in the JOURNAL for November, 1890, page 498.

#### A CHILIAN CRUISER.

The armored cruiser, *Capitan Prat*, built for the Chilean Government by the Compagnie des Forges et Chantiers, at La Seyne, France, was recently launched there. The chief dimensions of this ship are: Length, 328 ft.; breadth, 60 ft.; mean draft, 25 ft.; displacement, 6,900 tons. Her engines are expected to work up to 8,000 H.P., and to give the ship a speed of 17 knots with natural draft, and 19 knots with forced draft.

The armor protection consists of a water-line belt, a central barrette covering the engines, and turret shields for the large guns, with shield protection for the smaller ones.

The armament includes four 24-cm. (9.45-in.) Canet guns in turrets; eight 12-cm. (4.72-in.) Canet rapid-fire guns; four



THIRD-CLASS CRUISER "LE TROUDE," FOR THE FRENCH NAVY.

The engines are to work up to 6,400 H. P. with natural draft, giving a speed of 17½ knots; and to 9,800 H. P., with forced draft, giving a speed of 19 knots. The capacity of the coal-bunkers is 570 tons, giving a radius of action, at full speed with natural draft, of 4,500 knots.

#### A NEW FRENCH BATTLE-SHIP.

The plans prepared for the new French battle-ship *Jauréguiberry* have been approved by the Ministry of Marine, and work will be begun at once on the ship. The designs were made by Chief Engineer Lagane, and the ship will be built at La Seyne. The principal dimensions are: Length, 108.50 m. (355.8 ft.); breadth, 22.15 m. (72.65 ft.); depth, 14.63 m. (47.98 ft.); draft of water aft, 8.45 m. (27.71 ft.); displacement, 11,818 tons. The engines are to work up to 13,275 H.P. with natural draft, and to give the ship a speed of 17 knots an hour.

The ship will have a belt of water-line armor varying from 275 to 450 mm. (10.82 in. to 17.71 in.) in thickness, and will be further protected by an armored deck 70 mm. (2.75 in.) thick, and by a cofferdam filled with celluloid and backed by a plate 100 mm. (3.93 in.) thick. There will be four turrets protected by plates 370 mm. (14.56 in.) thick, placed in a square, and each carrying a large gun; also four smaller turrets 100 mm. (3.93 in.) thick and each carrying two smaller guns.

The main battery will consist of two 30-cm. (11.81-in.), two 27-cm. (10.62-in.), and eight 14-cm. (5.51-in.) guns, and the secondary battery of four 65 mm. (2.55-in.) and twelve 47-mm. (1.85-in.) rapid-fire guns; eight 37-mm. (1.45-in.) revolving cannon, and six torpedo tubes.

A special feature of this ship will be the employment of elec-

57-mm. (2.24-in.), and four 47-mm. (1.85-in.) Hotchkiss guns; six 37-mm. (1.46-in.) revolving cannon; five 11-mm. (0.43-in.) Maxim guns, and four Canet torpedo tubes. The guns are all provided with electrical apparatus for firing, and electric motors are provided for hoisting the ammunition and working the turrets. The arrangement of the guns is such that the fire of three 24-cm. and four 12-cm. guns can be concentrated on any point.

#### A FRENCH LIGHT CRUISER.

The accompanying illustration, from *Le Yacht*, shows the new cruiser, *Le Troude*, built for the French Navy by the Société des Chantiers et Ateliers, at Bordeaux. On the trials this ship made the following record: In two hours' steaming under forced draft, the engines showed 6,247 H.P., and the ship a speed of 20.9 knots an hour; in a 12 hours' trip at full speed, with natural draft, 3,393 H.P., and an average of 17.6 knots; in a six hours' trip at cruising speed, 1,591 H.P., and an average of 14.2 knots. Fig. 1 is a side-view; fig. 2 a front view and fig. 3 a deck plan.

*Le Troude* is a cruiser of the third class, 312 ft. long, 31.16 ft. extreme breadth, 14.1 ft. mean draft and 1,880 tons displacement. Her armament is light, consisting of four 14-cm. (5.5-in.) guns, four 47-mm. (1.85-in.) rapid-fire guns, four 37-mm. (1.46-in.) revolving cannon and four torpedo-tubes.

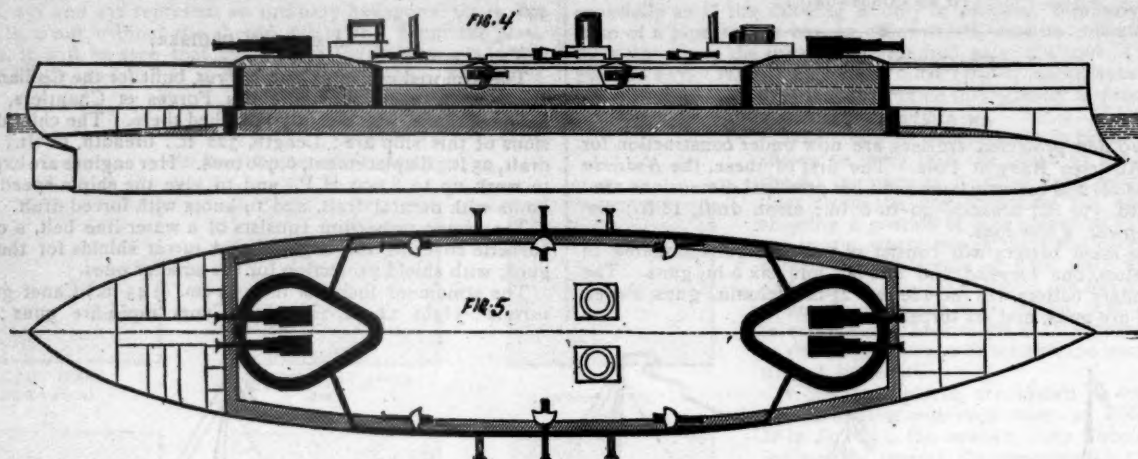
There are two screws, each 13.4 ft. in diameter and 16.6 ft. pitch. Each screw is driven by a compound engine having cylinders 37 in. and 74 in. in diameter and 36 in. stroke. The steam is furnished by five cylindrical boilers, each 10 ft. 2 in. in diameter and 19 ft. long, and having three fire-boxes. The working pressure is 100 lbs. usually.

## TWO NEW ENGLISH WAR-SHIPS.

Two large ships for the English Navy were launched at Portsmouth, February 26. The first, the *Royal Arthur*, is a twin-screw steel cruiser 360 ft. long, 60 ft. wide, and 7,350 tons displacement. She has a protective or armor deck of steel extending from stem to stern, but no vertical armor protection. This deck springs from the ship's sides at a point 3 ft. to 4 ft.

The armament will be as follows: Four 13½-in., 67-ton guns on the summit of the barbette; ten 6-in. guns in broadside; 24 small rapid-fire guns, and seven torpedo-tubes.

The ship will have a belt of armor with steel face and iron back on the compound system. This will have a maximum thickness of 18 in., and will be 8½ ft. deep, 3 ft. being above and 5½ ft. below the load water-line. The ends of the port and starboard sides of the belt will be joined by athwart-ship



ENGLISH BATTLE-SHIP "ROYAL SOVEREIGN."

below the water-line and slopes upward until reaching a point above the water-line. It is in the middle part (in an athwart-ship direction), practically flat. This form is that adopted in the midship part of the vessel; at the ends the deck is practically flat. The maximum thickness is 5 in. on the slopes and 2½ in. on the horizontal part. The coal bunkers are arranged to give protection above and below the water-line.

The engines are designed to give out 12,000 indicated H.P. with forced draft and 7,500 H.P. with natural draft, the respective calculated speeds being 20 and 18 knots per hour. The armament will consist of two 9.2-in. guns and twelve 6-in.

armored bulkheads of 14 in. thickness. The top edges of the port and starboard belt will be joined by a flat horizontal steel deck 3 in. thick.

At this point the ship may be likened to a shallow box or tray of armor placed bottom up, the sides dipping below the water-level and the inverted bottom consisting of the steel deck. Beyond the ends of the citadel so formed the vessel is not protected by vertical armor at all, the only protection being a 3-in. steel deck wrought below the water-line. Above the citadel already described, and at the extreme ends, are placed the two barbettes. These are pear-shaped structures heavily armored

Fig. 6.

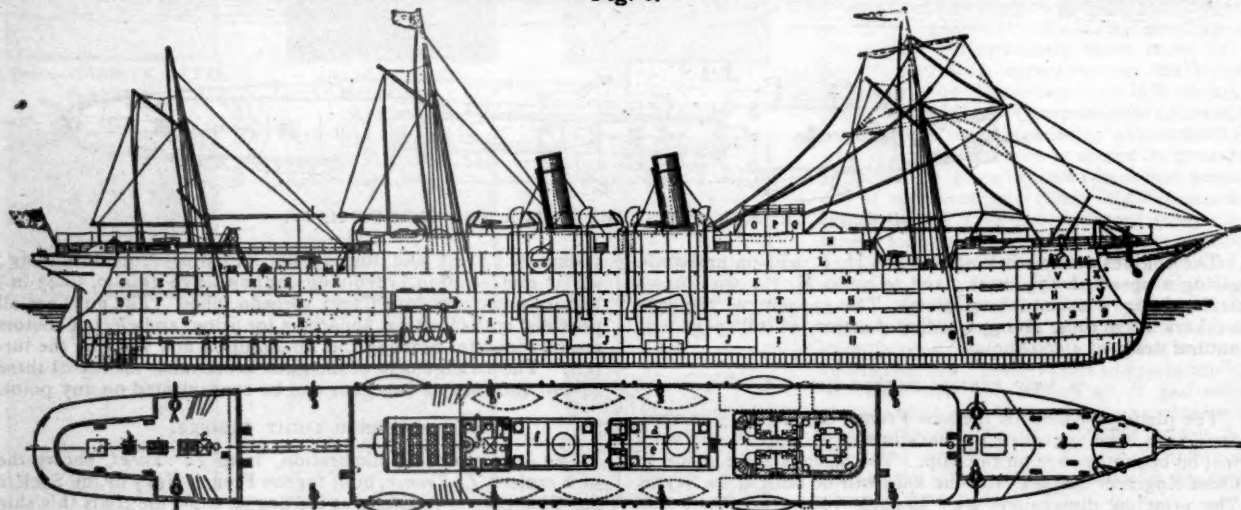


Fig. 7.

AUXILIARY OR RESERVE CRUISER "EMPRESS OF INDIA."

guns, and a number of small rapid-fire guns. The coal endurance will be 10,000 knots at ten-knot speed.

The *Royal Sovereign* is the largest battle-ship yet built; the general arrangement of guns and armor is shown on the accompanying diagram, figs. 4 and 5. She carries her heavy armament en barbette, and is propelled by twin screws. The length is 380 ft., the breadth 75 ft., and the displacement is calculated at 14,150 tons. The engines are designed to exert about 9,000 indicated H.P. with natural draft, and the corresponding speed will be about 16 knots per hour. With forced draft the horsepower is put down at 13,000 indicated, and the corresponding speed is estimated at 17½ knots. The estimated speeds, it should be stated, are those with the ship fully laden. The "radius of action," or "coal endurance," at speed of 10 knots, is to be 5,000 knots; at a speed of 16 knots, 1,800 knots.

vertically, but having no armored top or horizontal component. In each barbette is placed, side by side, a pair of 67-ton guns, two pointing forward and two aft, but both, of course, having an extensive arc of fire on either broadside. The guns are carried in the open, above the barbette, pointing over the top of the structure.

The armor protection of the *Royal Sovereign* is completed by a more lightly-armored citadel covering that part of the ship between the two barbettes—overlapping them to some extent—and above the 3-in. deck already mentioned. The armor line is of steel and 5 in. thick. It rises to a height of 9½ ft. above water, and it covers 145 ft. of each side. It is in and upon this structure that the secondary armament will be placed, there being two sponson ports on each side, while the guns mounted above are protected by armored shields.

## AN ENGLISH AUXILIARY CRUISER.

The accompanying illustration gives a longitudinal section and deck plan of the *Empress of India*, a new ship just completed by the Naval Construction & Armament Company, at Barrow-in-Furness, England, for the Canadian Pacific Company, and intended for the line between Vancouver and Hong Kong. This ship, although built for passenger and freight service, is built under conditions imposed by the English Admiralty, fitting it for service as a cruiser in case of war. The principal dimensions of the ship are: Length, 485 ft. over all; breadth, 51 ft.; mean draft, 24 ft. 6 in. The ship is built on the double-bottom system and is divided into numerous watertight compartments. It has full accommodation for a large number of passengers, and is provided with an electric light plant and other improvements. It is propelled by twin screws driven by triple-expansion engines, which on the trial trip developed a total of 9,720 H.P., giving the ship a speed of 18.5 knots an hour. With 7,725 H.P., a speed of 16.67 knots was reached. In ordinary service the speed is expected to be 15 knots an hour, which will enable the ship to make a trip from Vancouver to Yokohama in 12 days and 18 hours.

The ship is provided with all necessary fittings and arrangements to carry a number of 4-in. guns, and as a cruiser could be made into quite a formidable ship. Under the contract it is subject to be taken by the Admiralty at any time at a fixed payment. There are two sister ships—the *Empress of China* and the *Empress of Japan*—under construction at Barrow for the same line. The Company will receive a postal contract from the English Government, and has also a subsidy from the Canadian Government for the line.

In the accompanying illustrations, the letters *A* show the position for the 4-in. guns; *B*, rapid fire guns; *C*, sailors' quarters; *D*, magazine; *E*, freight; *F*, fire-room; *G*, refrigerator-room; *H*, freight; *I*, coal-bunker; *K*, first-class cabin; *L*, dining-room; *M*, baggage-room; *N*, saloon; *O*, captain's cabin; *P*, chart-room; *Q*, steering apparatus; *R*, second-class cabin; *S*, mail-room; *T* and *U*, store-rooms; *V*, ship stores; *W*, water-tank; *X* carpenters' room; *Y* sail-room; *Z* anchor chains. The loading crane and capstan are shown at *a* and *b*; the donkey engine at *c*; the condenser and tank at *d* and *e* and the auxiliary boiler at *f*. The position of the engines and boilers is also given on the diagram.

## Recent Patents.

## DODGE'S MACHINERY FOR HANDLING COAL.

THE appliances shown in fig. 4 are the invention of Mr. J. M. Dodge, of Philadelphia. The engraving shows the intent of the invention, the operation of which is described as follows in the specification:

"*M* and *M'* are masonry supports for the lower ends of a pair of trusses inclined in opposite directions at or about the angle of repose of the pile and connected at their upper or



DODGE'S COAL-HANDLING MACHINERY.

meeting ends, so as to constitute the legs of a sheers structure, and *R* the rod or other connection between the feet of the sheers to prevent further spread. Suitable lateral guys are provided to stay the sheers in an upright position.

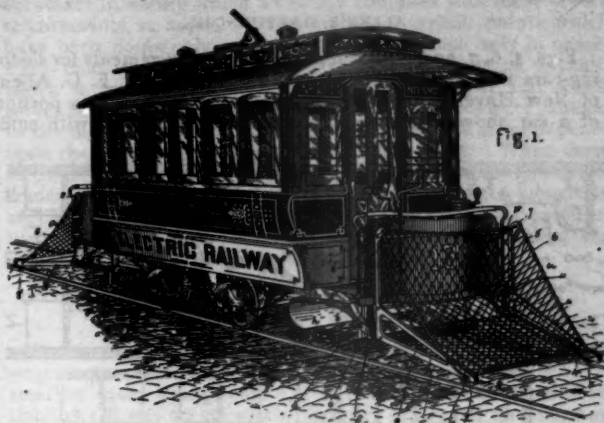
"The operation will be largely understood from the above description and a reference to the drawings. In the present instance the material is fed to the horizontal portion at any convenient point between *W*<sup>1</sup> and *W*<sup>2</sup>, and after it leaves the level at *W*<sup>2</sup> it is carried up by the lower run of the conveyer and discharged onto the pile at its various stages of formation."

The number of the patent is 446,814.

## APPLEYARD'S SAFETY DEVICE FOR STREET-CARS.

Little description is needed of the "device" illustrated by the engraving herewith, which is the invention of Mr. A. E. Appleyard, of Boston. As shown by the illustration, he provides a kind of receptacle or basket in front of the car "to receive the body of an individual or animal that may be caught on the track by the car." This receptacle is composed of a strong frame hinged to the car-body at *b*, the front end being

supported on small wheels 8, 8, which run on the track. The frame, as shown, is provided with a strong netting made of twine or rope, so that it may be said that this invention is intended to "rope in" trespassers on the track. A sort of sub-



APPLEYARD'S SAFETY DEVICE FOR STREET-CARS.

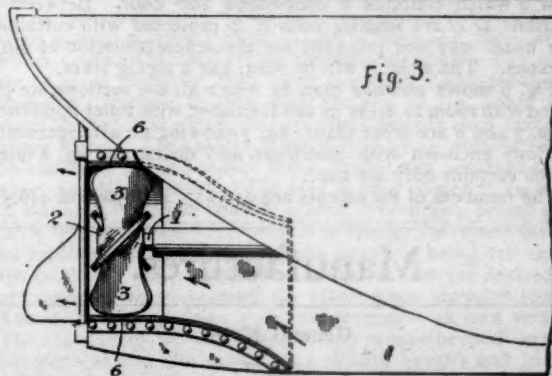
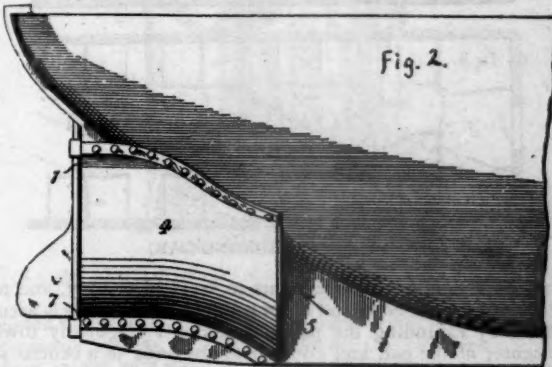
sidary fender *h* is also provided to catch those who escape the net. The number of the patent is 443,738.

## DOCK'S MARINE PROPELLER.

Figs. 2 and 3 are views of the stern of a vessel with this "improvement" applied to it. In fig. 3 the casing around the propeller is shown in section. The inventor describes his improvement as follows:

"4 is a casing surrounding the propeller, made flaring at the forward end 5, and by easy curves converging to a cylindric form of the diameter of the propeller-blades, which fit and turn in it, but without contact or friction.

"The water is directed toward the propeller-blades by the guides 4, so that it passes at its highest velocity through the



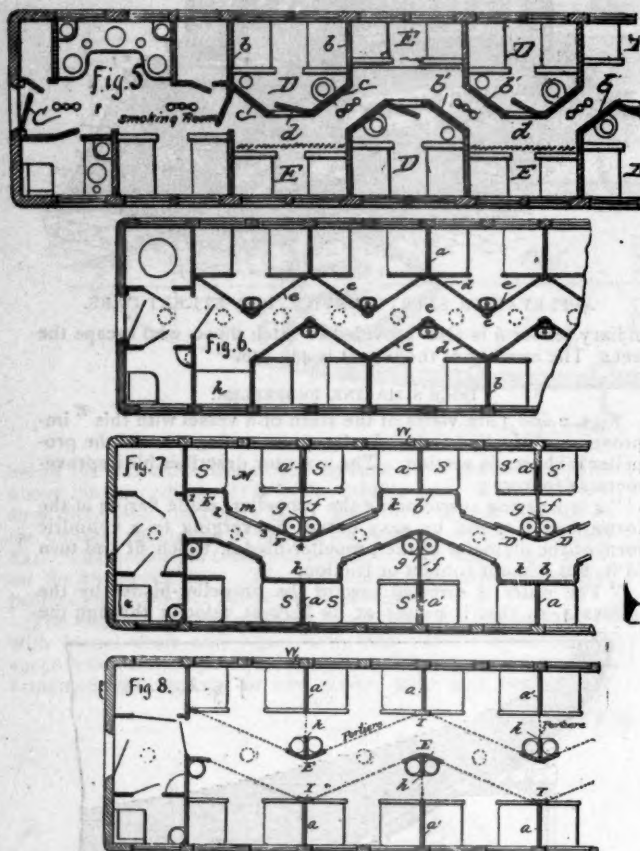
DOCK'S MARINE PROPELLER.

throat 6 of the guide, where the propeller engages it, and thus is prevented from diverging or spreading away from the propeller 3, and is delivered with the fullest effect in a solid stream from the after end 7 of the guide 4, and since the inertia of the fluid is most effectively operative when opposed to bodies moving at highest velocities, the support afforded by the water as a nut for the screw 3 to act upon being at the place of greatest velocity, it has the least slip possible, and the propelling effect is proportionably improved."

Probably some readers will be disposed to add an interrogation mark after the last paragraph. The inventor is Mr. Herman Dock, of Philadelphia. The number of the patent is 442,614.

#### ALLEN'S SLEEPING-CAR.

Figs. 5, 6, 7, and 8 represent plans of improvements for sleeping-cars that have recently been patented by Mr. E. G. Allen, of New Haven, Conn. Fig. 5 represents a plan of a portion of a car showing the improved compartments *DD* with suffi-



ALLEN'S SLEEPING-CAR.

cient space to allow the occupants to dress in privacy, and provided with a wash-bowl and other toilet articles. This is accomplished by extending the paneled section *c* diagonally toward the center of the car, and connecting the ends to a central section *d* which contains a door-frame and door. Between the sections *DD* are smaller ones *EE* protected with curtains in the usual way and intended for the accommodation of single persons. The aisle, it will be seen, has a zigzag form.

Fig. 6 shows another plan in which all the sections are provided with room to dress in and furnished with toilet appliances. Figs. 7 and 8 are other plans, fig. 7 showing an arrangement of sections enclosed with partitions and doors, and fig. 8 one in which curtains only are used.

The numbers of the patents are 440,295, 445,870, and 446,315.

## Manufactures.

### General Notes.

THE new works of the Newport News Ship Building & Dry-Dock Company cover 60 acres of land, having a water front on deep water of 1,825 ft. The buildings already erected cover 5 acres, and include office, boiler, blacksmith and machine-shops, wood-working shop, storage sheds, power-house and a number of others. On the water front there are four piers respectively 60 x 900, 60 x 350, 80 x 350, and 60 x 550 ft. in size, and an outfitting basin 900 x 500 ft. There are in the yard 8 shipways, two being 420 ft., two 450 ft. and four 500 ft. each, so that 8 vessels of the largest size can be under construction at once. The dry dock is of timber of the Simpson pattern, simi-

lar to that at the Norfolk Navy-Yard, its dimensions being: Length, 600 ft.; width on top, 130 ft.; width on bottom, 50 ft.; width at entrance, 93 ft.; draft of water over gate sill, 25 ft. A marine railroad capable of hauling out a ship of 2,000 tons is under construction. The shops are fitted with machinery of the latest pattern, and are supplied with hydraulic traveling cranes of 40 tons capacity, so that the largest work can be handled without difficulty. There is one derrick, with a lifting capacity of 130 tons, besides many smaller derricks distributed through the shops.

THE Schenectady Locomotive Works are building a Forney locomotive with 17 x 24 in. cylinders for the Erie & Wyoming Valley Railroad; it will burn anthracite coal.

THE iron filling and finishing paint made by Felton, Rau & Sibley, Philadelphia, has been approved and adopted by a number of leading manufacturers, and its use is rapidly increasing.

ON February 23 last, as a train on the Baltimore & Ohio Southwestern was side-tracked to let another pass, at Remington, O., the second train came around the curve, before the other train had got clear of the main track, at such speed that it was impossible to stop it, and scraped the side of the third car of the side-tracking train for about 12 ft., catching the fourth car under the corner, turned it over on its side into the ditch, injured several passengers and the conductor. This car was equipped with the Consolidated Car-Heating Company's fire-proof heater, which was located in the corner struck by the engine. Though the heater was somewhat loosened from its fastenings, lifted and tipped, it was but slightly broken, and notwithstanding a brisk fire was burning in it, no conflagration took place. Had the car been equipped with an ordinary heater, the trainmen say nothing could have prevented the car from taking fire.

THE Southern Pacific shops, in Sacramento, Cal., have just completed a compound locomotive, which is rebuilt from a simple engine made at the Schenectady Works some years ago. This engine is of the 12-wheel type, having eight 51-in. drivers and a four-wheel truck. The boiler is 60 in. in diameter; the grate area is 30 sq. ft. and the total heating surface 1,884 sq. ft. The engine is of the two-cylinder type, with a Pitkin intercepting valve placed between the high and low-pressure cylinders. The cylinders are 20 x 26 in. and 29 x 26 in. the ratio being 1:2.1. It will be used on the mountain grades over the Tehachepi Pass.

THE American Steel Car-Wheel Company, South Boston, Mass., is making car-wheels cast from Bessemer steel. These wheels are in use on a number of railroads, where they will receive a thorough trial.

THE Rhode Island Locomotive Works, in Providence, have recently delivered to the Union Pacific six 10-wheel engines, with 19 x 24-in. cylinders and 62-in. driving-wheels; these engines have boilers 64 in. diameter of barrel and Belpaire fire-boxes. Other recent deliveries include two 10-wheel engines, with 18 x 24-in. cylinders and 54-in. drivers to the Boston & Maine, and two eight-wheel engines of meter gauge to a railroad in South America. The latter have boilers 46 in. in diameter of barrel, 15 x 20-in. cylinders and 48-in. drivers.

THE Joseph Dixon Crucible Company has begun the building of an addition to its works in the form of a three-story building 25 x 100 ft. in size, which will be used principally for office purposes. The present offices will be added to the factory, together with a new building four stories high and 100 x 100 ft. in size. The new building will contain large additions to the manufacturing plant, which will increase the capacity of the works.

THE Brown & Sharpe Manufacturing Company, Providence, R. I., is erecting a new four-story brick building, 100 ft. long and 56 ft. wide. The construction is similar to that of the main machine-shop buildings, and is practically fire-proof throughout. The walls are 20 in. thick, and have two ventilating flues 6 x 8 in. in each pier. A large proportion of the wall space is occupied by windows. The floors and roofs rest on iron beams, supported by three transverse rows of iron columns 16 ft. apart. The heavier beams are in pairs and are 20 in. deep; the lighter are 15 in. deep. The latter are 8 ft. from center to center, and support brick arches 4 in. thick, 10 in. rise. The floors are 5 in. thick. The first layer from beam to beam is 2 3/4 in. splined spruce plank. The second layer is 1 1/2 in. spruce laid diagonally with the plank, and the third, or top layer, is 1 3/8 in. hard pine laid parallel with the 3 in. plank. The roof is solid concrete covered with tar and gravel. The stairways are iron. Benches are the stand-

ard pattern, and sanitary closets will be used. The building will be devoted to the manufacture of a variety of small tools and instruments for accurate measurements.

THE Lunkenheimer Brass Manufacturing Company, Cincinnati, O., has purchased the entire plant and business of the Porteous Brass Company of the same place, and has removed the machinery and tools of the latter Company to a new addition recently constructed to its own works, the capacity of which is thus largely increased.

THE Sewall steam coupler, manufactured by the Consolidated Car-Heating Company, Albany, is now in use on railroads covering a mileage of 37,562 miles and using 7,080 passenger cars. This includes such lines as the Boston & Maine; the Chicago & Northwestern; the Grand Trunk; the Louisville & Nashville; the Richmond & Danville, and many other important lines. The McElroy coupler, also manufactured by the Consolidated Car-Heating Company, is in use on railroads having a mileage of 8,188 miles and 2,557 passenger cars. The system of the Consolidated Company has recently been specially commended by the Railroad Commissioners of Maine.

THE Baldwin Locomotive Works, Philadelphia, are building 13 Forney locomotives for the Manhattan Elevated Railroad in New York. The boilers are 42 in. diameter of barrel; the fire-boxes are of the Belpaire type, which is in use on a number of the Manhattan engines. The grate area is 16 sq. ft.; the total heating surface 430 sq. ft. The cylinders are 12 x 16 in.; driving-wheels 42 in. and truck-wheels 26 in. in diameter. The fixed wheel-base is 5 ft.; total wheel-base, 16 ft. The total weight is 47,000 lbs. in working order.

THE Armington & Sims Engine Company, Providence, R. I., has recently added to the works a new machine-shop, and a steam laboratory and testing room, completely fitted up. This company has recently completed a compound engine of 1,000 H.P., to drive a train of rolls in the mill of the Washburn & Moen Company at Worcester, Mass. This engine will be run from 250 to 300 revolutions per minute.

THE first vessel built at the yard of the Chicago Ship Building Company, Chicago, was launched March 14. This ship, the *Marina*, has been built for the Minnesota Steamship Company, and is the first steel steamer ever built on Lake Michigan. She is 308 ft. long over all, 40 ft. beam, and 24 ft. 6 in. deep. The engines are of the triple-expansion type, with cylinders 24 in., 38 in., and 61 in. in diameter and 42 in. stroke. The steam is furnished by two steel Scotch boilers, each 14 ft. in diameter and 12 ft. 6 in. long.

RECENT sales by Riehle Brothers, in Philadelphia, include a 200,000-lbs. testing machine to Cornell University; 50,000-lbs. testing machines to the Baltimore & Ohio Railroad, to Paige, Carey & Company, Wheeling, W. Va., and to the Colorado Agricultural College; a 5,000-lbs. transverse tester to the Dickson Manufacturing Company, Scranton, Pa.; a 1,000-lbs. cement tester to the City Engineer, Salt Lake, Utah; a vibratory testing machine to the Thomson-Houston Electric Company, Lynn, Mass. They have also sold a large number of track and other heavy scales, and Robie screw-jacks.

THE locomotives built by the Baldwin Works, Philadelphia, for service through the St. Clair Tunnel, are said to be the heaviest ever built in this country. They are carried on 10 wheels, all coupled and all 50 in. in diameter, the total wheel-base being 18 ft. 3 in. The boiler barrel is 74 in. in diameter and has 280 flues, 2½ in. in diameter and 13 ft. 6 in. long. The fire-box is 11 ft. long and 42 in. wide, and is built to burn anthracite coal. Water is carried in two long side tanks, each holding 1,000 gallons. The cylinders are 22 x 28 in. These engines weigh 195,000 lbs. in working order, giving 19,500 lbs. per wheel.

#### Asphalt Paint.

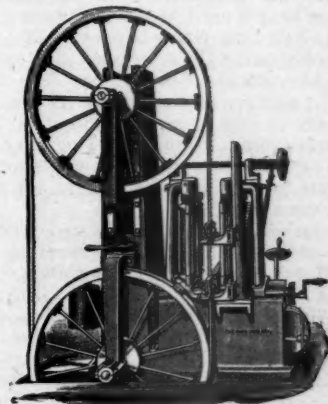
To find a paint of lasting qualities, which will prevent the corrosion of iron due to atmospheric agencies, is a problem with which engineers have dealt earnestly for many years. Until within quite recent years little has been known in this country of the valuable properties of asphalt, and to many they are still unknown. In the popular mind it is often confused with certain coal-tar products, which, though similar in appearance, differ essentially from asphalt in character. Asphalt oils are of a non-volatile nature, and are therefore permanent, while, on the other hand, coal-tar and linseed oils are volatile, and, therefore, non-permanent. Herein lies the secret of the paint problem. In order to prevent rust, some substance must be used as a coating for the iron, which is impervious to air and

moisture, and it is of equal importance, that it may remain impervious, that it should be unaffected by the heat of the sun and by exposure to the air. It is claimed that there is no other substance in nature which so nearly complies with these severe requirements as asphalt. The so-called asphalt paints which have been commonly used in the past are such only in name. They contain, at best, but a very small per cent. of asphalt, which is incorporated in the form of a pigment and which serves no valuable purpose. Asphalt, on the contrary, should be the main constituent, since the virtue of such a paint depends upon the presence of the permanent asphalt oils. When these so-called asphalt paints are made in light colors, durability becomes subservient to ornamentation. The virtues sought in asphalt are lost by substituting for it the necessarily large quantity of light-colored pigment essential in counteracting the natural dark color of the asphalt.

#### The Improved Method of Splitting Lumber.

IN this progressive age there has of necessity arisen, step by step, improved mechanism for band-sawing. The ribbon of steel for many years could not be handled with a degree of reliability; it was an uncertain quantity to depend on; but now the band-saw, large and small, has become an essential factor in the sawing of lumber. The resaw also has become a standard machine, sought for from every section of the country; indeed, there is hardly a first-class establishment having a modern equipment which does not contain the resaw as a valuable adjunct.

The accompanying cut represents a No. 5½ band resaw, built to meet a demand for a machine of great capacity for use in car-building establishments, railroad-shops, etc. It is de-



No. 5½ BAND RESAW, MADE BY THE EGAN COMPANY, CINCINNATI.

signed and constructed for light and heavy work, and has an improved system of gearing, having the two front feed-rolls close to the saw blade. An ingenious device connecting the top of roller brackets enables it to straighten the plank while being sawed, making a great saving in time and material, and which commends itself to all practical sawyers. The wheels are 60 in. in diameter, with extra large hubs and spokes, and now made entirely of iron, with the rim of the lower wheel much thicker, and therefore very much heavier than that of the upper wheel. Each wheel is supported by an outside bearing on each side of the column, there being three bearings to both upper and lower shafts. The feed is very powerful, consisting of six large feed-rolls heavily geared, driven by a patent graduating feed, enabling the operator to change the speed instantly by turning a hand-wheel while the board is being fed through the machine. The guides seem to be the best yet devised, and are made so as to support the blade when crowded too fast. The roller back is also a great improvement as now arranged. The capacity of this machine is very great—beyond 20,000 ft. per day—and in the hands of a skillful sawyer and properly fixed for it, there is no trouble in reaching 35,000 or 36,000 ft. per day. It now carries a 6-in. blade, and works with equal facility in hard or soft woods, cutting 36 in. wide, and to the center of 12 in. thick. Several pieces of narrow stuff can be cut placed between the rolls one above the other. The rate of feed is from 0 to 65 ft. per minute; a larger size is built—No. 6—which carries an 8-in. blade, and is specially fitted for saw-mill work and the production of the largest quantities. The success of the No. 5½ has been of a remarkable character. For further information and details address the originators and builders, The Egan Company, Nos. 194-214 West Front Street, Cincinnati, O.

### The Westinghouse Troubles.

For several months past, the daily press has constantly referred to what it called the financial troubles of the Westinghouse Interests. While it is true that there are several industrial corporations which in one form or another bear the name of "Westinghouse," it is equally true that the "financial troubles" among these companies have been confined to what is known as the Westinghouse Electric & Manufacturing Company, or, in other words, to that company whose business consists in making and vending electrical apparatus.

The Westinghouse Machine Company, for instance, whose business consists in making and selling, through the medium of its agents in every part of the civilized world, its well-known Westinghouse engines, has had no financial trouble, and, to use a current expression, is "not in it!" Instead of curtailing its operations, this old reliable institution is still further increasing its capacity as rapidly and as much as it can. New tool and store-rooms are just approaching completion, and it is hoped by the management, during the coming spring or summer, to be able to add complete new erecting and testing shops fitted with large power cranes and all modern improvements, and which shops will have a producing capacity twice as great as the present ones. To those in want of steam-engines, as well as to those interested in the development, progress and enterprise of American manufacture, we suggest a careful perusal of the advertisement of the Westinghouse Machine Company, which appears elsewhere in this issue.

### Automatic Train Heating.

THE first railroad in the world to operate a whole system of trains in which the temperature is automatically regulated whenever steam heat is used, is the Delaware & Hudson Canal Company. Its Belt Line trains between Albany and Troy are all thus equipped with the Consolidated Car-Heating Company's devices. The temperature regulator has been in service since January 1, 1891, and the directions for its use practically are: "Turn on steam to cars from the locomotive and leave every valve on the train entirely alone." The interior temperature of the cars, with ventilators well open, will shortly after steam is turned on rise to 70° and remain there, no matter what the outside temperature may be.

On the invitation of the Consolidated Company a large number of prominent railroad men inspected this system in operation on March 11 and 12. There were present representatives of nearly all the leading lines of the Northern and Eastern States. After carefully watching the operations of the heating apparatus, the visitors were entertained at the Albany Club by the Company.

The exhibition of the car-heating system in use on the Albany Belt Line trains was so successful that the Consolidated Car-Heating Company has extended its invitation to railroad men to visit Albany and inspect that system until April 15, or as long as heat is required in the cars. As the system is in regular every-day use, it can be seen at any time, but if the Company is notified, its representative will meet any visitors who may wish to see the working of the system.

### Baltimore Notes.

PLANS for the new bridge to be erected on North Avenue, for the use of the Belt Railroad, the Northern Central and the Western Maryland, have been submitted and approved. The plans were prepared by Mr. Frederick H. Smith, Civil Engineer for the City, and approved by Mr. J. H. Rea, Engineer for the Belt road. The bridge is to be of stone, 400 ft. long, of three arches, with a roadway of 60 ft.; it will cost about \$400,000, and will be paid for, jointly, by the City and the Belt Railroad.

The power houses of the Cable Railroad, to run between Druid Hill and Patterson Parks, have been completed, and are ready for the cable, which is expected within the next 10 days.

The South Baltimore Car Works, Curtis Bay, have received an additional order from the Baltimore & Ohio Railroad to make thorough repairs to 50 gondola cars. The United States Rolling Stock Car Works, Hegewich, Ill., have secured a similar order. Having cars repaired by contract is a new feature in the Baltimore & Ohio management. These works are building 250 hopper-bottom gondola cars, of 60,000 lbs. capacity, for the Youghiogheny Coal Company.

A new 10-wheel engine, cylinders 20 x 24 in., with a steel cab, has just been turned out of the Mt. Clare Works. A trial trip will be made on the Philadelphia Division, after which it will be sent to the Trans-Ohio Division. This is the first completed on an order for 10. In addition to these, four 10-wheel

ers have just been purchased from the Pittsburgh Locomotive Works, for use on the Pittsburgh Division.

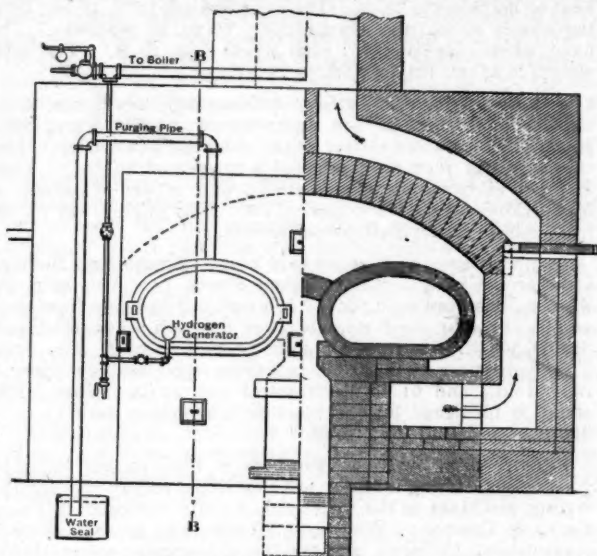
It is said that the Baltimore & Ohio shops at Keyser, W. Va., and Connellsville, Pa., will soon be consolidated with the shops at Cumberland, Md., which is to be the terminus of the Eastern Division instead of Keyser, as at present.

The citizens of Martinsburg, W. Va., are greatly exercised over the rumor that the work of the Baltimore & Ohio shops at that point is to be transferred to Brunswick (old Berlin), where the Company has purchased a large tract of land. Brunswick will be known as the "drilling ground," as all freight trains for Washington, Locust Point, Hagerstown, and all points on the Valley Railroad, will be made up there.

### The Gesner Rust-Proof Process.

THE rust-proof process invented by Mr. G. W. Gesner, of New York, has passed the experimental stages, and the inventor has for some time past had a plant in practical operation in South Brooklyn, where a large number of articles have been treated. In this process, it is claimed, no scale or coating is formed, but the body of the surface is converted into a compound of iron, hydrogen and carbon, which will not oxidize, and thoroughly protects the article treated. Moreover, there is no alteration of form, distortion, or warping during the process.

The accompanying engraving shows a half front view and a half section of Mr. Gesner's furnace, from which its construc-



THE GESNER RUST-PROOF FURNACE.

tion can be clearly seen. It consists substantially of a bench of two ordinary gas retorts placed side by side in a furnace heated by a grate. The process itself is conducted in the following manner: The retort being carried to a temperature of 1,000° to 1,200° F., as may be determined by the character of the articles to be treated, the latter are introduced by means of a crane and pulley, care being taken that they do not touch one another. After closing and testing the retort, the heating continues for about 20 minutes. Then steam is introduced into what Mr. Gesner calls a hydrogen generator, shown in the drawings. It is a simple pipe, open at the rear end. Mr. Gesner claims that in the passage of the steam through this generator hydrogen is generated, which fills the retort. This operation goes on for 35 minutes, at the end of which time half a pint of naphtha is permitted to flow into the retort for 10 minutes. The flow of hydro-carbon is then stopped, and the steam which has been allowed to enter the generator during the whole operation is continued for 15 minutes longer. The whole time employed in the operation is, therefore, 1 hour and 20 minutes. The purging pipe, which dips into an open vessel of water, as shown, to the depth of 1½ in., carries off any excess of gases produced in the operation.

In cases where articles treated are ornamental, such as art hardware, they are given a bath of cold whale-oil or paraffine-oil to render them more even in tone. In other articles no oil is used. The plant now established at South Brooklyn is rated at a capacity of 6 tons per day of boiler tubes, 7½ ft. in length, or 2 tons of ornamental hardware, the rate of production of treated goods depending upon the time required for handling them. The average cost of fuel per day is reported by Mr. Gesner to be \$1.75, including coal for the boiler.

The following is an analysis, made by Stillwell & Gladding, of New York, of a sample of the surface of cast-iron prepared by the process: Carbon, 1.01 per cent.; hydrogen, 0.22 per cent.; sand, 6.70 per cent, and iron, 66.10 per cent. The chemists add that the iron is present as metallic iron and as oxides of various constitution.

A series of careful tests of iron and steel plates treated by this process shows practically no effect upon the strength and resistance of the metal.

### OBITUARY.

**CHARLES KELLOGG**, President of the Buffalo Bridge Company, and head of the Kellogg Tube Works, died at his home in Findlay, O., March 14. Mr. Kellogg was well known throughout the country as a civil engineer. He was an inventor of some note, being the originator of the seamless tube which bears his name. He had passed a long and useful life, having reached the age of 75 years.

**WILLIAM G. DOUGLAS**, who died at his home in Wilson County, Va., March 15, aged 72 years, was one of the oldest civil engineers in the country, and for many years prominently connected with the Baltimore & Ohio Railroad. His first work was on the surveys of the Orange & Alexandria—now the Virginia Midland—Railroad. He made the first survey for the Manassas Gap Railroad, from Manassas to Strasburg, Va., and the preliminary survey for the Rockfish Gap Tunnel through the Blue Ridge for the Chesapeake & Ohio Railroad. He was Civil Engineer on the Baltimore & Ohio, doing work under Chief Engineer Latrobe on the Hancock Division. In 1851 he was Division Engineer on the Central Ohio Railroad from Wheeling to Columbus. He then formed a copartnership, under the firm name of Douglass, Smith & Company, and contracted for building all the cars and bridges of the Central Ohio and other roads. The panic of 1857 broke up his business. In 1872 he was Division Engineer on the Atlantic & Lake Erie Railroad, in Ohio. For some years past he has been retired from active work.

### PERSONALS.

**J. P. HOVEY**, late of the Northern Pacific, has been made General Foreman of the Baltimore & Ohio shops at South Chicago, in place of C. H. CAMPBELL, resigned.

**GEORGE T. JARVIS** has resigned his position as Superintendent of the Ohio Division of the Baltimore & Ohio Railroad. His successor is R. W. BAXTER, late Trainmaster.

**F. M. LEWINSON** and **GEORGE A. JUST** have entered into partnership as consulting and contracting engineers, and have established an office at No. 90 Nassau Street, New York.

**GARDINER C. SIMS** was the special representative of steam engineering at the recent electric anniversary in Providence. Mr. Sims served his apprenticeship at the New York Central shops in West Albany, and after several years' varied experience, joined Mr. Armington in forming the firm of Armington & Sims. Their specialty was the building of quick-running engines, and their type of engine has seemed to be particularly well adapted to electric work, achieving a great success.

**WILLIAM F. SHUNK**, of Pittsburgh, has been appointed by the Intercontinental Railroad Commission Organizing Engineer, and will have charge of the formation of the parties which are to make preliminary surveys through Central America. The Secretary of War has detailed the following officers for duty in connection with these surveys: CAPTAIN EDGAR L. STEVER, Third Cavalry; FIRST LIEUTENANTS S. M. FOOTE, Fourth Artillery, and ARTER ALLEN, Third Infantry; SECOND LIEUTENANTS A. S. ROWAN, Ninth Infantry, A. T. BUFFINGTON, Seventh Infantry, C. A. HEDEKIN, Third Cavalry, and SAMUEL REBER, Fourth Cavalry. Three other officers are yet to be selected, making ten in all.

### PROCEEDINGS OF SOCIETIES.

**Conference of Railroad Commissioners.**—The Second Annual Conference of Railroad Commissioners was held in Washington, March 3, about 30 persons being present. Judge Cooley, of the Interstate Commission, was chosen President; Mr. George C. Crocker, of Massachusetts, Vice-President, and E. A. Moseley Secretary. Judge Cooley made his annual address, which was a discussion of the railroad problem, with special relation to the present system, or rather lack of system, in making rates.

The report of the Committee on Legislation gave rise to a discussion with regard to securing uniformity in the adoption of automatic couplers and train brakes.

Commissioner Schoonmaker read a paper on the use of private cars, which gave rise to some discussion.

On the second day there was a discussion on the rate question, which ended in the adoption of resolutions in favor of laws regulating rates; such laws in the different States to be made as uniform as possible.

The subject of Car Couplers was taken up, and a representative from the Switchmen's Association made an appeal for uniformity in couplers, with a view to securing safety to trainmen. After discussion it was resolved to appoint a Committee of five to urge upon Congress the need of action to secure the equipment of freight cars throughout the country with automatic couplers and train brakes.

The Committee on Rates was continued, with instructions to report to the next Conference such further facts and suggestions as may be considered best. The Committee on Uniform Safety Appliances was directed to report to the next Conference on the question of National Legislation on Lighting and Heating Passenger Cars.

The Conference adjourned, to meet again in Washington on the second Wednesday of April of next year.

**American Society of Civil Engineers.**—The Secretary announces that the Annual Convention will be held at Lookout Mountain, Tenn., beginning about May 20 next. The detailed arrangements will be announced in a future circular. Members desiring to contribute papers or discussions should send an abstract of the papers to the Secretary not later than April 20, and should advise the Secretary as soon as possible whether they intend to contribute.

At the regular meeting, March 4, it was announced that the proposed amendment to the constitution relating to local societies had been lost by a vote of 182 to 189. The other proposed amendments had been carried by a vote of 289 to 35.

The following elections were announced:

**Members:** Willfred E. Cutshaw, Richmond, Va.; George L. Dillman, Winlock, Wash.; Francis L. Hills, Wilmington, Del.; John A. Bense, George A. Just, New York; Captain James L. Lusk, U. S. Eng., Washington.

**Juniors:** Oscar E. Selby, Louisville, Ky.; John G. Spielman, Paterson, N. J.

Mr. R. L. Harris read a paper on Coffier Dams, describing one without timber or iron in its construction. This was discussed by members present.

**Franklin Institute.**—The Committee on Science and Arts of the Franklin Institute has awarded the Elliott Cresson medal to Tinius Olsen, of Philadelphia, for his improvement in Testing Machines.

The Committee has awarded the John Scott legacy medals and premiums as follows: J. E. Wootten, of Philadelphia, improvements in Locomotive Boilers; Outmar Mergenthaler, of New York, for his improvement of the Linotype; Robert Hadfield, of Sheffield, England, for his discovery of Manganese Steel; Wallace H. Dodge, of Mishawaka, Ind., for his system of Rope Transmission; William Anderson, of London, England, for his process of Water Purification; E. C. Johnson, of New York, for his system of Interior Electric Conduits; J. B. Hannay, of Glasgow, Scotland, and Alfred Shedlock, of New York, for their improved system of illumination known as Lucigen.

**National Electric Light Association.**—At the annual meeting, in Providence, February 17-19, of which some notice was made last month, the following officers were chosen for the ensuing year: President, C. R. Huntley, Buffalo, N. Y.; First Vice-President, James I. Ayer, St. Louis, Mo.; Second Vice-President, M. J. Francisco, Rutland, Vt.; Executive Committee, A. J. DeCamp, Philadelphia; A. J. Corriveau, Montreal; John A. Seely, New York; A. M. Robertson, Minneapolis; C. R. Faben, Toledo; H. H. Fairbanks, Worcester; E. F. Peck, Brooklyn; E. W. Rollins, Denver; J. J. Burleigh, Camden.

It was unanimously decided to hold the next meeting, in August, at Montreal, Canada.

**Master Mechanics' Association.**—The Committee on Locomotives for Freight and Heavy Passenger Service (Pulaski Leeds, Louisville, Ky., Chairman) ask for information as to the relative merits of the mogul and ten-wheel types, limit of weight on a driver and other particulars as indicated by experience.

The Committee on Operating Locomotives with Different Crews ask for information and notes of experience gained in running locomotives with more than one crew; especially as to cost of fuel and repairs; also for opinions as to the merit of different systems of running. Answers are to be sent to John A. Hill, 96 Fulton Street, New York City.

Secretary Sinclair has issued the following: "A general index of the annual reports of this Association, from the 1st to the 23d inclusive, has been prepared and is ready for sending out. Members desiring to obtain the Index will receive it free of charge, on applying to the Secretary. The Index is of service only to those who have the back reports and use them for reference.

The Committee on the Car Coupler Question, of which Mr. John Hickey, Kaukauna, Wis., is Chairman, is collecting information as to the working of the M. C. B. standard coupler and the present condition of opinion among the members of the Association in relation to this coupler.

The Committee on Axles, of which Mr. John Mackenzie, Cleveland, O., is Chairman, is collecting statistics as to breakages of iron and steel axles, and as to the service of these axles under locomotive tenders and cars.

**Illinois Society of Engineers and Surveyors.**—The annual meeting was held in Springfield, Ill., January 28, 29 and 30. A number of interesting papers were presented, among which were Roads and Road Drainage, by T. S. McClanahan; Office Records, by E. A. Hill; Map Making, by W. W. Abell; Pennington's Aerial Ship, by G. C. Harvey; Straightening and Deepening Water Course, by D. L. Braucher; Improvement of Public Grounds, by S. F. Balcom; Water Works of Peoria, by Jacob Harmon; Government Lock and Dam at Mount Carmel, by G. C. Harvey.

The following officers were elected: President, Arthur N. Talbot; Secretary and Treasurer, S. A. Bullard; Recording Secretary, C. M. Richards; Chairman Executive Committee, D. L. Braucher.

**Boston Society of Civil Engineers.**—The annual dinner was given at Young's Hotel, Boston, March 10, about 130 members and guests being present. After dinner speeches were made by President Fitz-Gerald, Professors Swain, Drown and Shaler, Messrs. Howe, Spencer, Peters, Stebbins and others.

At the annual meeting, in Boston, March 18, the Secretary reported a total of 265 members. Reports were received from the standing committees. The following officers were elected for the ensuing year: President, F. P. Stearns; Vice-President, W. E. McClintock; Secretary, S. E. Tinkham; Treasurer, Henry Manley; Librarian, F. W. Hodgdon; Director, G. F. Swain.

**New England Water-Works Association.**—A regular meeting was held in Boston, March 11. Mr. Hiram F. Mills, of the Massachusetts Board of Health, read an elaborate paper on the Relation of Water-Supply to Typhoid Fever, which was discussed at considerable length by members present.

Descriptions were given of a new covered reservoir at Franklin, N. H., by F. L. Fuller; a new pumping engine at Lynn, by John C. Haskell, and the Malden water-works, by S. M. Allis.

**Engineers' Club of Philadelphia.**—At the regular meeting, February 21, it was ordered that the amendments to the Constitution be printed and a note taken at the next meeting on the same.

The Secretary then presented, for Mr. Percy T. Osborne, a large view of the Rivermont Bridge at Lynchburg, Va., accompanied by a communication describing this structure.

Mr. Rudolph Hering presented a paper upon the Action of Sea Water on Steel and Iron. This paper was followed by some discussion, but as Mr. Hering proposed to continue the subject at a future meeting, it was resolved that further discussion be postponed until the completion of the paper by Mr. Hering.

At the regular meeting, in Philadelphia, February 7, Mr. Charles H. Haupt presented an illustrated paper on Photographic Surveying, of which the following is an abstract:

1. The location of points horizontally and vertically from photographs depends, in the first place, on the determination of the position of the point of sight for any view which is at a constant distance equal to the equivalent focus of the lens, and directly opposite the center of the picture. The horizontal projections of points may now be connected with this point of sight, and horizontal angles thus determined. Vertical angles for heights are determined from their tangents.

2. Triangulation of any point in the field may thus be effected; as it is possible to measure the true angle between this point and some other fixed point from two views taken from different stations.

3. A photographic map of the Schuylkill and Fairmount Park was shown. The map was made from photos taken from each side of the river. A panoramic view of the horizon was taken from each station, each view being oriented from the compass bearing of its center. The base line was on the west bank and was 947 ft. long. A check station was taken on the west bank.

The scale used was 200' to 1" and points platted to this scale from the three principal stations checked exactly. Heights also checked up satisfactorily. The field work took but eight hours; plating about three days.

There was considerable discussion of this paper.

The Secretary presented, for Mr. J. M. Stewart, a paper by Mr. J. Bernard Walker upon a Boltless Rail Joint. Mr. Stewart, who is Chief Engineer of the Oregon Pacific, is about to try it on his road, and considers that one of its principal values is that such rail joints will be cheap to maintain, as the constant tightening of bolts is not, in his opinion, necessary.

**Civil Engineers' Club of Cleveland.**—At the regular meeting, February 10, Professor Frank H. Neff was elected a member. The Committee on Nominations reported two lists of candidates. A Committee was appointed to arrange for the annual meeting and dinner.

Mr. H. M. Kingsley read a paper on Surveys for the Cleveland Water Works Tunnel, in which he said that the original location was in a straight line from the shore shaft to the crib in the lake, but on account of striking quicksand, some detours were made, complicating the location. On account of the unequal settling of the crib, throwing the shaft out of plumb, the direction at that end was obtained from two plumb lines only 6 ft. 4 in. apart, yet the intersection of the two headings was only 6 in. north of the calculated point. The measured length of the tunnel was only 0.096 ft. shorter than the calculated length in a distance of 7,100 ft. After the completion of the tunnel test levels were run connecting with bench marks upon the shore end with the lake end, and they were found to differ only by 0.016 ft.

The paper was illustrated by specimens of wood, bark and nuts found at a depth of 60 to 80 ft. below the surface; also by a map showing the location of the tunnel as originally laid down and as finally built; also the location and soundings for the proposed extension  $2\frac{1}{2}$  miles further into Lake Erie.

The eleventh annual meeting was held at the Club Rooms, March 10. A brief memoir of Mr. Joseph M. Blackburn, member of the Club, lately deceased, was presented, and resolutions of respect were adopted.

Ballots for the election of officers for the ensuing year were canvassed, and the following officers elected: President, Joseph Leon Gobeille; Vice-President, M. E. Rawson; Secretary, A. H. Porter; Treasurer, N. P. Bowler; Librarian, C. M. Barber; First Director, F. C. Osborn; Second Director, S. J. Baker.

A revised constitution was adopted. The retiring officers presented their annual reports. The President's report showed the Club to be in excellent condition, and its work during the past year equal to that of any year previous, and the prospect for the future bright and flattering.

The Secretary's report showed that the total membership now reaches 157, a gain of 20 during the past year. There were two deaths during the year and only one resignation, and no member was dropped for non-payment of dues. There were 13 papers read before the Club during the year, and there was one discussion upon a technical subject.

The Treasurer's report showed the finances to be in a healthy, substantial condition.

The Librarian's report showed that more room is urgently demanded for the better accommodation and proper arrangement of the Engineering Library, that is slowly but steadily growing.

The Chairmen of the various Committees on programme made brief reports upon the progress made in the different departments of Engineering during the year. Three of these reports were especially interesting, that of Professor C. L. Saunders on Surveying and Civil Engineering, that of Mr. Walter Miller on Mechanical Engineering, and that of Professor C. S. Howe on some recent discoveries in Astronomy.

The various Committees on programme for the ensuing year were appointed. A vote of thanks was extended to the retiring officers.

**Engineers' Club of Cincinnati.**—At the regular meeting, February 19, there was a discussion on the question of the most equitable method of assessing and calculating the cost of street improvements, the point being whether such improvements should be paid for by assessing the cost upon abutting property or from a general fund.

Colonel Latham Anderson read a paper on a Single Trap System of House Drainage, which included a general discussion and criticism of the modern system of house drainage and a description of a proposed plan for the use of a single trap between the sewer and the house. This was generally discussed.

**Engineering Association of the South.**—At the regular meeting, in Nashville, Tenn., February 12, the committee appointed to prepare a memorial to the Legislature for the repeal of the Tennessee law levying a special tax on architects and engineers, reported that answers from 38 States showed that no tax was levied on these professions.

The Committee on Highways recommended that a standing committee be appointed of one member from each State represented in the Association to secure as frequently as possible papers from members on this subject to be read, discussed, and then printed and generally circulated. The report was approved.

Mr. Charles J. Norwood, of Frankfort, Ky., was chosen a member. The death of Mr. Eben Pardon was announced.

Mr. J. B. Marbury read a paper on Weather Forecasts, giving an account of the system adopted by the United States Signal Bureau.

At the regular monthly meeting in Nashville, Tenn., March 12, the standing Committee on Highways was announced as follows: J. R. Carter, Birmingham, Ala.; B. T. Burchard, Fernandina, Fla.; A. V. Gude, Atlanta, Ga.; E. L. Corthell, Chicago, Ill.; C. O. Bradford, New Albany, Ind.; John McLeod, Louisville, Ky.; J. Kruttschnitt, New Orleans, La.; William Stickney, Buffalo, N. Y.; W. Starling, Greenville, Miss.; W. H. Bixby, Wilmington, N. C.; S. Whinery, Cincinnati, O.; E. C. Lewis, Nashville, Tenn.; C. W. Richardson, Richmond, Va. This Committee includes one member from each State represented in the Association.

President Atkinson invited the Association to hold its main meeting at Earlinton, Ky., in the western coal-field, and the invitation was accepted.

Mr. C. J. Norwood, State Inspector of Mines of Kentucky, read a paper on Mine Inspection, giving a complete exhibit of the present status of the 91 mines in Kentucky subject to inspection, both as to the general character of the mines, the kind of ventilation and safety appliances used. The inspection of mines in the States was first begun in 1884. At present ventilation by natural means is prohibited. Fans are used at 16 mines and ventilating furnaces at the rest. The law requires 100 cub. ft. of air per man per minute to be delivered into mines, and headings are not allowed to be opened more than 60 ft. in advance of air supply. It also requires safety cages on all hoisting cages. Fire-damp has been found in only 10 mines in the State, and explosions have occurred in only two. The principal accidents have been caused by the falling of roofs, blasting and dust explosions. Maps of the workings of each mine are required to be filed twice a year. The law has been generally complied with by mine owners without compulsion, and the sentiment is in favor of close inspection.

**Alabama Industrial & Scientific Society.**—The first regular meeting was held in Birmingham, January 28. It was stated that 85 members have joined the Society. The officers are: President, Cornelius Codle, Jr.; Vice-Presidents, Thomas Seddon, W. E. Robertson, C. P. Williamson, M. C. Wilson, and Horace Harding; Secretary, William B. Phillips; Treasurer, Henry McCalla.

The President made an address on the Work of the Society, and the best means of carrying it out. Mr. W. Haskell read a paper on Mine Surveying, which was discussed.

Resolutions were passed requesting the President to present a petition to the Legislature for an increased appropriation for the Geological Survey of the State. The next meeting will be held at Anniston in April.

**Civil Engineers' Society of St. Paul.**—The regular meeting, February 2, was the joint meeting of the St. Paul and Minneapolis Societies, and was opened by a dinner, followed by an address of welcome to the visitors. A committee was nominated to prepare a memorial of the late J. L. Gillespie,

and the Secretary was directed to accept the gift of 28 volumes from his estate.

Mr. Van Duzee, of the Minneapolis Society, read a paper on Sewer Construction in Minneapolis, giving the history and the general plan of the system. There are now 80 miles of sewer in the city, 20 miles of which were built last year, wholly by day labor. The greater part of the storm water is carried off by intercepting sewers, and all the sewers are flushed automatically.

This was followed by a discussion on Mr. Münster's paper, read at the January meeting, on a Short Method to Results obtained by Gordon's Formula, his method being generally indorsed.

At the regular meeting, March 2, it was decided to accept the offer of rooms in the Court House; and other business was transacted, including arrangements for future meetings. John B. Hawley and C. F. Hollingsworth were elected members.

**Engineers' Club of Duluth.**—This Club was organized at Duluth, Minn., February 21, when the following officers were elected: President, William B. Fuller; Vice-President, L. F. Brewster; Secretary, M. W. Lewis; Treasurer, F. B. Edwards; Librarian, S. A. Parsons.

It was decided to hold regular meetings on the second Saturday of each month.

**Engineers' Club of St. Louis.**—At the regular meeting, February 4, it was resolved to purchase the library of the late Mr. Whitman, the money to be raised by subscription.

Professor M. A. Howe read a paper on Strength of American Vitriified Sewer Pipe, giving the result of a number of experiments made to determine the strength of such pipe. These experiments included tests to determine what load of water would burst the pipe; to ascertain the behavior of the pipe when subjected to sudden blows; to determine the load a length of pipe would sustain at the center when supported at both ends; to determine the maximum pressure pipe will stand when surrounded by sand, and to determine the strength of cement joints. This paper was generally discussed by members present.

At the regular meeting, March 4, A. J. O'Reilly and I. O. Walker were elected members. A memorial of the late S. F. Bennet was presented. The Committee was instructed to purchase portraits of Captain J. B. Eads and C. Shaler Smith.

Mr. N. W. Perkins, Jr., read a paper on Brick-making Machinery, which sketched the history of brick-making, and described in detail a number of the machines now in use. This paper was generally discussed by members present.

**Engineers' Club of Kansas City.**—The officers of this Club elected at the February meeting are: President, F. E. Sickles; Vice-Presidents, F. W. Tuttle and W. Kierstead; Treasurer, W. Stone; Librarian, V. Wittmer; Directors, J. A. L. Waddell and E. J. Farnsworth.

**Denver Society of Civil Engineers.**—The officers of this Society for the ensuing year are: President, George G. Anderson; Vice-Presidents, R. D. Hobart and J. S. Titcomb; Secretary and Treasurer, George W. Angell. The papers read so far this season have been as follows:

February 24, The Cañons of the Colorado, by W. H. Graves.  
March 10, Recent Improvements in Mining Machinery, by John McNeil, E. J. Hall, and George L. Ramsay.

March 24, Underground Surveying, by George Holland, J. S. Luckraft, and L. S. Preston.

The President's annual address was delivered at the meeting of February 10. In the April meetings papers will be presented on Bridges and on Irrigation.

**Montana Society of Civil Engineers.**—On January 17 the members of this Society made a special visit to the works of the Montana Company, at Marysville, where there was a general inspection of the mills and mines of the Company and a short meeting was held.

In the evening a meeting was held in Helena, at which the annual report of the Secretary was submitted showing the expenditures during the year to be \$272, and a balance of \$63 on hand. The Association has now 57 active and three associate members, a net increase of 8 during the year. Ten regular and two special meetings were held.

The following officers were then elected for the ensuing year: President, Elliott H. Wilson; First Vice-President, John Herron; Second Vice-President, George H. Robinson; Secretary and Librarian, James S. Keerl; Treasurer, Albert S. Hovey; Trustee for three years, W. W. de Lacy.

The new President then made a short address. The meeting was concluded by a dinner at the Hotel Helena, which was much enjoyed, and at which toasts were proposed and responded to as follows: "Old Times in the Northwest," Colonel W. W. de Lacy; "Future of Engineering," John Herron; "Matrimony and its Relations to Engineering," A. S. Hovey; "The Railroad Engineer," H. J. Horn, Jr.; "Mining Engineering," A. B. Knight and C. W. Goodale; "The Law," Judge Hiram Knowles; "Engineering Societies," J. S. Keerl; "The Ladies," E. H. McHenry; "Surveying in 1730," Judge H. H. Blake.

**Technical Society of the Pacific Coast.**—At the regular meeting in San Francisco, February 2, Mr. J. Richards read a paper on Abrasive Cutting in the Mechanic Arts, which was discussed. This is to be followed by another paper on the same subject.

At the regular meeting, March 6, Constructor A. W. Stahl, U. S. N., read a paper on the Theory of Wave Motion, which was generally discussed.

**Tacoma Society of Civil Engineers.**—At the regular meeting, in Tacoma, Wash., February 20, Walter M. Bosworth read a paper on Electricity as a Motive Power.

Mr. J. V. Browne read a paper on Comparative Strength of Washington and Eastern Timber, in which he said that the fir and pine of Washington were noted for their great strength.

**Southern & Southwestern Railway Club.**—A regular meeting was held in Chattanooga, Tenn., February 19. The first subject for discussion was Brakes Hung to the Car Body vs. those Suspended from the Truck. This was opened by a paper prepared by Mr. J. J. Casey, who advocated hanging from the truck. The discussion was continued by Messrs. Meehan, Gibbs, Leeds, Burgess, Setchel, Howson, Patterson, Thomas and others, a variety of views being expressed.

The second subject for discussion was Means of Preventing the Forgery of Defect Cards, upon which a number of members spoke. Mr. Gibbs gave a number of instances in which forged cards had been sent with cards, and a specimen card was presented so arranged as to make alterations difficult or impossible.

It was decided to hold the next meeting in Memphis, Tenn., and the subjects chosen were Breaking of Side Rods, and Exhaust Nozzles.

**Western Railway Club.**—At the January meeting, in Chicago, Mr. W. H. Marshall read a paper on Vertical Plane Couplers and Air-Brakes, which called out a long discussion. Mr. D. L. Barnes read a short supplement to his paper on the same subject, which was presented at the December meeting. The main point made in the discussion was that the use of the vertical plane coupler was very important in connection with the introduction of air-brakes on freight cars.

Mr. J. N. Barr then read an interesting paper on Irregular Wear of Locomotive Tires, which was accompanied by a number of diagrams and tables. The discussion of this paper was postponed until the next meeting.

**Northwestern Track & Bridge Association.**—The regular meeting was held in St. Paul, February 13. Discussions were had on Mr. Pearson's paper on the Temporary Expedients in Case of Fire and Washout, and also on Rail Joints.

Mr. B. T. McIver read a paper on the Best Clamphead for Lower Chord of Howe Truss Bridges.

At the annual meeting in St. Paul, the following officers were elected: President, John McMillan; Vice-President, A. Amos; Secretary, D. W. Meeker; Treasurer, John Copeland. The President made an excellent address, reviewing the year's work.

The paper on Preserving Ties presented at the previous meeting was generally discussed.

Mr. J. Kindelan read an interesting paper on Rail-joints, describing a large number of joints devised and in use.

## NOTES AND NEWS.

**A New Pavement.**—Some time ago an experimental section of street pavement composed of wooden blocks and cast-iron supporters was laid down in Sheffield, England. The accompanying engravings, from *Iron*, illustrate a further experiment in the same town on similar lines, but instead of cast-iron, as in the former case, wrought steel is used in combination with wood. In place of the cast-iron upright stud of a cruciform section previously used at the angles of the blocks, there is



now an angle-piece of steel (fig. 1) having a base or foot which rests directly on the concrete foundation. The advantages of steel over cast-iron are obvious, but the difficulty has been to adapt steel in such form as would be producible without making the cost so great as to preclude its general adoption. The first piece of combined wood and iron paving has now been in use three years, and shows little or no sign of wear. The piece described in our previous notice is still in use under exceptionally heavy traffic. The third piece, which comprises about 100 square yards, has been laid down in Queen Street, Sheffield, where there is a great amount of traffic. Half of it is in cast-iron, but of much lighter construction than that in Savile Street, the other half is in steel, as shown in fig. 2 of our engravings. It has been in use seven months. This pavement is made by the Carmaxill Road Paving Company, of Sheffield.

**Heating Metals by Electricity.**—An illustration of a simple adaptation of the transformability of electrical energy to an industrial end is afforded by a recent German patent for a process and apparatus for superheating metals already fused. A glance at the accompanying figure (fig. 1), which represents a longitudinal section of the apparatus, will show the plan adopted. A cast-iron box *A*, capable of being divided into two parts, is packed full of any suitable refractory material,

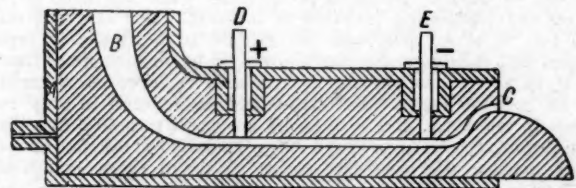


FIG 1.—Apparatus for Superheating Molten Metal.

such as sand, fire-clay, or magnesia, and a channel *B* formed therein, funnel-shaped at the top, becoming parallel-sided when it has reached a horizontal position and taking an upward curve at *C* before the end of the box is reached. Two electrodes *D* and *E* pass through stuffing-boxes packed with asbestos or some similar material at once capable of withstanding heat and of acting as an insulator. The metal to be superheated flows in at *B*, passes along the horizontal channel, serves as a conductor between *D* and *E*, and has its temperature raised thereby, and escapes at *C*. Consider the simplicity of such a method compared with any more usual mode of heating. With a common furnace fuel would have to be burned in a refractory chamber surrounding the vessel containing the liquid to be superheated. If a continuous flow were required this vessel would take the form of a tube, through whose walls every unit of heat imparted to the liquid would have to be transmitted, while the surface from which radiation could take place would not be that of the tube itself but of the necessarily larger chamber surrounding it.—*London Electrician*.

**Pumping Work at Bay City.**—The pumping plant of the water-works at Bay City, Mich., under charge of Superintendent E. L. Dunbar, includes one Gaskill horizontal compound condensing crank and fly-wheel pumping engine, maximum

capacity 5,000,000 gallons in 24 hours; one Holly quadruplex compound condensing crank and fly-wheel pumping engine, maximum capacity 3,000,000 gallons in 24 hours; one horizontal high-pressure piston engine, driving through gears two No. 10 Holly rotary pumps, maximum capacity 2,500,000 gallons in 24 hours. There are three horizontal return tubular boilers, each 5 ft. 6 in. diameter and 16 ft. long, with 105 tubes  $2\frac{1}{2}$  in. diameter. The boilers are set in separate brick arches and the fuel used is slabs and edgings from the saw-mills.

The total work done by the pumps last year was as follows:

	Time run.	Water pumped.
Gaskill engines.....	8,674 hrs. 0 m.	975,759,367 gals.
Quadruplex engines....	87 " 54 "	11,885,445 "
Rotary pumps.....	19 " 19 "	1,126,641 "
Total	8,781 hrs. 13 m.	988,771,453 gals.

Of the water pumped there was, under ordinary or domestic pressure—average 41.6 lbs.—970,324,930 gallons; under fire pressure—average 86.5 lbs.—18,446,523 gallons. The greatest quantity pumped in one day was 3,510,694 gallons; the least, 2,038,487 gallons.

There was used 2,822 cords of wood—estimated equal to 776 tons of coal—the average cost being 65.8 cents per cord. The cost of pumping was as follows:

	For fuel.	Total.
Total cost for the year .....	\$1,845.00	\$6,077.63
Cost per million gallons pumped.....	1.87	6 15
Cost per million gallons raised 100 ft. . .	1.64	5.39

The total cost includes fuel, supplies, salaries, and repairs. The average lift of all the water pumped was 114 ft. from the surface of the water in the wells.

The quantity of water supplied was the greatest ever used in one year. The record of the works for the year was an excellent one.

**The Sault Water-Power.**—The citizens of Sault Ste. Marie, who bonded the town for \$500,000 to help the water-power project, expect English capitalists to take hold of the enterprise. The report of Colonel Hope, a celebrated Scotch engineer, is entirely favorable to the scheme, and was made at an expense of \$20,000. Colonel Hope made, for the first time, a survey of the amount of water which passed through the river. On the plans of the survey the force will be 70,000 H.P., which will be placed to consumers at \$6 per H.P. per annum. The principal use of the power, according to plans of the promoters, will be in grinding pulp, the surrounding country furnishing immense amounts of spruce and balsam, which make the very best of paper fiber. It will doubtless also be used for running stamp-mills for the reduction of lean silver, nickel and copper ores, which would not pay if the reduction was made by steam. It is proposed to line the canal with stone at an expense of \$2,000,000 and make it as solid and permanent as possible.—*Marine Review*.

**The Greatest Ocean Depths.**—Rear-Admiral George Belknap, U. S. N., read a paper in October before the Asiatic Society of Japan, on the depth of the Pacific on the east coast of Japan, with a comparison of other ocean depths. He gave interesting details of his own experience while surveying a cable route on the east coast of Japan and along the Aleutian chain and Alaska to Puget Sound. His conclusions are that a trough of extraordinary depth and extent exists along the east coast of Japan and the Kurile Islands. From his own investigations and a study of the data obtained by previous researches, Admiral Belknap advances the interesting proposition that "as a rule the deepest water is found not in the central parts of the great oceans, but near, or approximately near, the land, whether of continental mass or island isolation."

The *Bulletin* of the American Geographical Society, reviewing the work done, shows that the *Challenger* discovered the great depression of 4,075 fathoms in the North Pacific near Guam; that the United States Coast Survey steamer *Blake* found a depth of 4,561 fathoms in the North Atlantic near Puerto Rico; and that the British surveying steamer *Egeria* found depths of 4,428 fathoms, 4,295 fathoms, and 4,530 fathoms near the Friendly and Cook Islands in the North Pacific.—*Goldthwaite's Geographical Magazine*.

The greatest of these ocean depths, that found by the *Blake*, is equal to 5.183 miles, showing that the inequalities of the ocean bed are fully as great as any on the land surface.

**The Beginning of Iron Making in America.**—It is certain that at Lynn, in the Province of Massachusetts Bay, was cast, in the year 1645, the first piece of hollow ware made in America—"a small iron pot capable of containing about one quart." This pioneer of all American-made castings was in existence in

1844, but recent efforts to ascertain its whereabouts have been unsuccessful. The works at Lynn appear to have been very prosperous for a number of years; but after a time they became unpopular, owing to the flowage of lands by their dam, and the great destruction of timber for fuel.

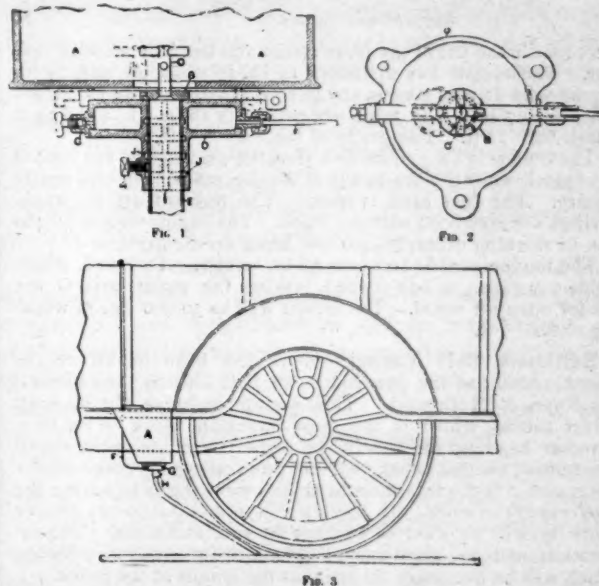
The Rev. William Hubbard, writing in 1677, says they were "strenuously carried on for some time, but at length, instead of drawing out bars of iron for the country's use, there was hammered out nothing but contentions and lawsuits." Just about this time Samuel Butler was writing his great poem in which he makes Hudibras say:

Alas! what perils do environ  
The man who meddles with cold iron!

a reflection which has been sadly appropriate in the case of too many American iron works.

After the establishment of this first successful "furnace" and "foundry" at Lynn, works for the manufacture of iron were erected in other parts of New England, and thence the business spread into New York, New Jersey, Pennsylvania, and Maryland. During the "French War" (1755) there were a number of furnaces in operation at which "cannon, bombs, and bullets" were made in great quantity, and many of these iron works furnished similar supplies to the Continental Army during the Revolution.—*W. F. Durfee, in Popular Science Monthly for December*.

**Sand-Drier for Locomotives.**—The accompanying illustrations show an improved sand-drier for locomotives, invented by Mr. J. Macdonald, of Tokyo, Japan, and which is intended



for use especially in damp climates, where the sand is apt to take up moisture and clog the pipes. In the illustrations, fig. 1 represents a vertical section of the drier, fig. 2 is a plan, and fig. 3 shows the arrangement as fitted; A is the sand-box, B is the sand-valve, and C the stirrer. An annular steam chamber D surrounds the sand outlet pipe E, and is supplied with steam by means of a small copper tube F, a drip-valve G being also provided to run off the water of condensation. The sand-pipe is capable of vertical adjustment, and is secured in any desired position by the set-screw H, and by a projection or nib on the pipe which fits into one of the annular recesses. We are informed that this apparatus has been in use on a large number of locomotives for some time in humid climates, with complete success. One line on which it is used has a prevailing gradient of 66 ft. to the mile for 14 miles.—*Industries*.

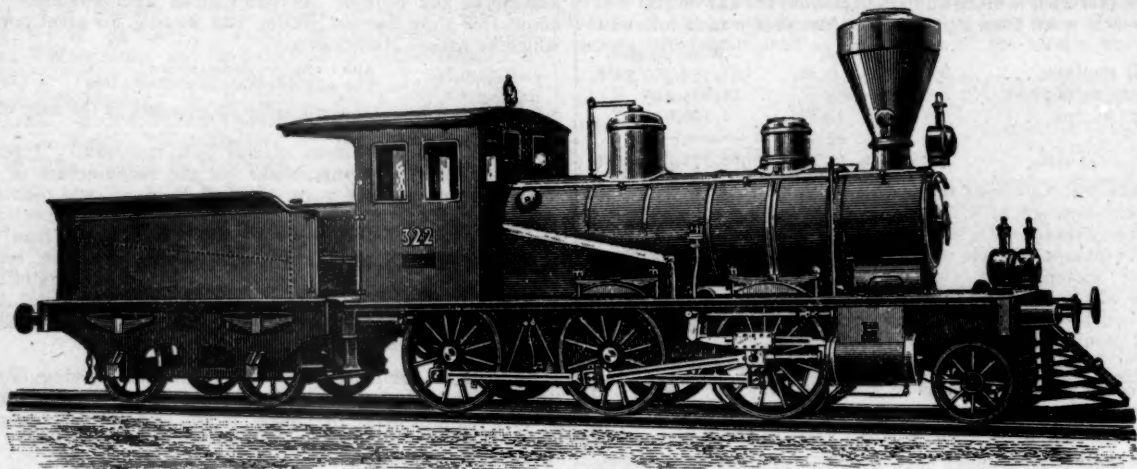
**Price of Gas in England.**—The *Engineer* says that the prices of gas supplied by the various companies throughout the country during the past year varied from 1s. 9d. = 40 cents per 1,000 ft. at Plymouth to 7s. 6d. = \$1.80 at Walton-on-the-Naze. The prices of gas supplied by local authorities varied from 1s. 10d. = 44 cents at Leeds to 6s. 3d. = \$1.50 at Bethesda, in North Wales. It is noteworthy that while Plymouth at 1s. 9d. = 40 cents and Leeds at 1s. 10d. = 44 cents made a profit, Bethesda at 6s. 3d. = \$1.50 did not produce sufficient revenue to pay expenditure. Local authorities average 267 cub. ft. per ton of coal carbonized less than companies.

In New York the price is now \$1.25 per 1,000 ft. Consumers will wish that a pipe line was possible between here and Plymouth.

**A Light Mogul Locomotive.**—The accompanying illustration shows one of 30 locomotives built by the Swiss Locomotive & Machine Works at Winterthur, Switzerland, for the Uleaborg Extension of the Finland State Railroads. This extension runs to Uleaborg, which is on the Gulf of Bothnia, in latitude 65° N., and is notable as being the most northerly railroad in the world, with the exception of one line in Sweden.

The engine is distinctly of the American type of mogul engine, with outside cylinders, Bissell truck, etc.; the main differ-

ences, viz., test piece and standard, are placed at opposite ends of a diameter of the rotating plate, against which they are pressed by equal weights. The standard used is Yvette sandstone, and first-class materials have a coefficient of from 1 to 1.40, while with second-rate materials the coefficient is between 1.40 to 2.40; if the wear is greater than that represented by the latter figure, the material is rejected. An additional test is made by placing specimens of the stones to be tested in a cylinder, which, like those used in clearing scrap iron from rust,



ences are in the use of the plate frame and the four-wheeled tender. The engine has cylinders 15 in. in diameter and 20 in. stroke; the driving wheels are 48.8 in. in diameter, and the truck wheels 30.7 in. The total wheel-base is 18 ft. 8 in.; the rigid wheel-base 12 ft. The gauge of the road is 5 ft.

■ The boiler is built to carry a working pressure of 150 lbs.; it is of steel, while the fire-box is of copper, made deep and nearly square. The fuel used is wood. The forward driving wheel springs are equalized with the truck. The engine weighs 56,400 lbs. in working order, 46,400 lbs. being on the drivers.

■ The tender is carried on four 36-in. wheels. The tank, which holds 990 galls., is box-shaped, leaving the upper part of the tender open for wood. The tender weighs 30,900 lbs. in working order.

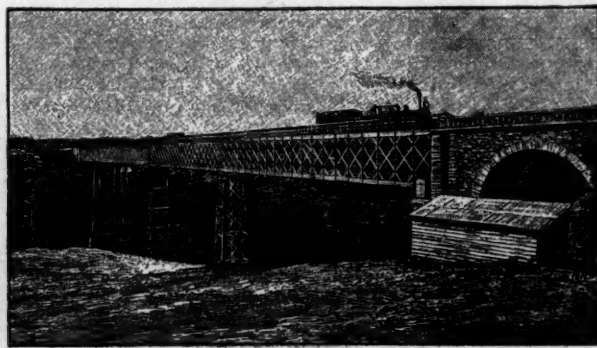
■ **Baltimore Belt Tunnel.**—Work has been begun on the fourth section of the new Baltimore Belt Line by the contractors Ryan & McDonald. This section includes the Howard Street tunnel, which is the most important work on the line. Another heading will shortly be begun from the south end of the tunnel, so that work will be progressing at both ends at once, and it is the intention to sink several shafts to hasten the progress of the work. In driving this tunnel temporary timber supports will be used to support the roof and sides. The excavation will be large enough to allow for a masonry lining, which will be necessary throughout the length of the tunnel.

**Testing Paving-Stones.**—The following plan of testing the

is mounted and rotates on an axis which does not coincide with its center of figure. The amount of detritus produced after the material has been treated for a certain time in this machine is compared with that from a standard rock under the same conditions.

**Aeronautics and Electricity.**—In order to show the application of electricity to aerial navigation, a captive balloon, capable of seating 10 persons, will be exhibited by Captain Rodeck at the forthcoming Frankfort Exhibition. The pulley which controls the ascent and descent will be operated by an electric motor, and a telephone wire will enable conversation to be carried on between those in the balloon and the people at the starting-point below. Experiments will be made with the view to the steering of the balloon by electricity, and in the filling of the balloon with electrically prepared water gas. Messrs. Siemens & Halske will make the electrical apparatus.

**The Malleco Viaduct.**—The accompanying illustrations, figs. 1 and 2, for which we are indebted to our contemporary, *La Nature*, represent a viaduct which was opened for traffic in October last, and which conveys the Chilean State Railroad across a deep valley, at the bottom of which runs the River Malleco, near Collipulli, in the southern part of Chili. The viaduct, which is constructed entirely of steel, has a height of 333 ft. from the level of the river, and is composed of five spans, each 232 ft. in length. The total length of the viaduct is 1,419 ft., the length of the steel portion being 1,160 ft. The



comparative value of paving-stones is adopted at the Paris Laboratory for Testing Materials: A sample of the rock of regular form is placed upon a horizontal plate, rotating round a vertical axis, and pressed against it by suitable contrivances. The wear is then compared with that of a standard material under the same conditions. The coefficient of wear is the proportion between the volumes worn, which can easily be ascertained by weighing the specimens, and determining the volume from this weight, and the specific gravity of the material in question. The rotating surface is cast-iron. The two speci-

depth of the girders forming the superstructure of the viaduct is 23½ ft., while the rails are laid at a height of about 327 ft. from the level of the river. The total weight of the viaduct is 1,550 tons. The designs were prepared by a Chilean engineer, Mr. V. Aurelio Lastaria, and the whole of the steel work, which was erected under the supervision of Mr. E. Vigneaux, was supplied by Messrs. Schneider & Company, Creusot, France.

The great difficulty of this undertaking was due to the extreme steepness of the banks of the ravine, and a great deal of time was taken in getting the material into position.